FLIGHT

The AIRCRAFT ENGINEER & AIRSHIPS

First Aero Weekly in the World

Founder and Editor: STANLEY SPOONER

A Journal devoted to the Interests, Practice, and Progress of Aerial Locomotion and Transport

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DIARY OF FORTHCOMING EVENTS

Club Secretaries and others desirous of announcing the dates of important fixtures are invited to send particulars for inclusion in the following list:

Jan. 10 ... **Meeting of the Bureau of the Fédération Aéronautique Internationale in Paris**

Jan. 20 ... **Lecture, "The Cost of Air-Ton-Miles, Compared with other Forms of Transport," by Lord Montagu of Beaulieu, before R.Ae.S.**

EDITORIAL COMMENT

The Encouragement of Civil Aviation

WE have before us as we write an interesting document, a part of which is devoted to a discussion of the future policy to be pursued in relation to civil aviation and its encouragement. We propose to make a fairly lengthy excerpt from this document, in order to point once more a moral we have often emphasised. On this subject of civil aviation, with particular reference to its bearing on defence, it is laid down that: "In time of war aviation will probably be the first arm of offence and defence to come into action. For this there must be an established industry and a trained and active air service. Aerial supremacy at the outset of hostilities would be a tremendous military advantage. Ultimate victory would unquestionably incline to the side that could establish and maintain supremacy in the air. Huge expenditure of money in time of danger and frantic efforts to train personnel and to develop hastily an aircraft industry from almost nothing will not do. There must be wise preparedness; there must be in healthy existence at least a nucleus of an industry capable of adequate expansion; there must exist civil and commercial aeronautical activities in all parts of the country, which would be the main support of the industry in time of peace. In pure self-defence the Government must encourage the development of commercial aviation. The alternative proposition is the creation and maintenance of a powerful standing military air service, relatively self-reliant in time of war. We cannot, however, afford the expense which such a policy would entail, and there would be no advantage in time of peace from such expenditure comparable in any way to the advantages to be gained from the support of civil aviation. We should maintain an active air service in time of peace, which should possess inherent strength, and be something more than a mere nucleus for expansion in time of war. In the final analysis, however, we must depend upon civil aviation to furnish a military reserve force. . . . The problem is to place our aircraft industry in a healthy condition, and to do this we must enter without delay upon a sane, sound policy for the development of civil aviation. The relative cost of fostering an organised plan to develop commerical aviation would be much less than the waste that would inevitably result from unprepared entry into war. Aside from military considerations, the fostering of commercial aviation would in time yield adequate return in itself in the form of promoting and strengthening our means of transportation, advancing the progress of civilisation and increasing the national wealth."

This, we know, reads like a quotation from our own editorial columns, but it is simply an extract from the sixth annual report of the United States National Advisory Committee for Aeronautics. It is significant to know that the views set forth have received the endorsement of the Secretaries of War, the Navy and Commerce, and also of the President himself. To comment upon them would be almost superfluous, but we cannot refrain from remarking upon the strikingly similar opinions which are held

by United States authorities and our own experts. We ourselves have consistently urged that the best means of ensuring the essential measure of air power against the day of war is the active encouragement of civil aviation, so that a powerful reserve to a nucleus fighting air service may be almost instantly available when called upon to assist the active force.

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State Aid to be Given? It would seem that recent occurrences in connection with civil aviation in this country, and notably the closing-down of the Airco service to France, have given great concern to the Government, since we understand that the Cabinet is at last seriously considering a scheme for subsidising in some shape or form an essential industry which is suffering from creeping paralysis for lack of the support which was promised two years ago, and has so far not materialised.

What shape the scheme is likely to take is not available, so that it would be idle to discuss the question in detail. This much may be said, that it is not likely to take the form of a subsidy on mileage flown. French experience has shown that, while such a subsidy is much better than the apathetic lack of support from which British civil aviation has suffered, it puts a premium on the use of obsolete and unsuitable machines, and leads to unnecessary flights which are made for the sole purpose of earning the subsidy. We may venture the hope that whatever the main lines of the Government scheme—assuming that report does not lie, and that there actually is a scheme—it will include that form of encouragement which we have so often urged upon the postal authorities of sending the bulk of the first-class mail matter addressed to Continental countries by air. We are perfectly confident that if this were done the cross-Channel services could pay their way and be quite independent of direct subsidies, which are never desirable, and only to be given when there is no other method of attaining a desired result. If this were done, and it were shown that, given some certain method of ensuring a paying load for each flight, civil aviation could stand upon its own feet, we should see services being opened up within the British Isles and private enterprise becoming more inclined to venture capital and effort in fostering the new transport. However, it is useless, as we have said, to discuss the matter in more than very general terms until it is made known what the views of the Cabinet are, and how it is proposed to give effect to them. When that happens we shall be better able to assess the precise value of the encouragement which now seems to be more or less definitely in sight.

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The Air Force Ensign The Royal Air Force is to have its own ensign, the design of which has been approved by His Majesty. It consists of a flag of R.A.F. blue, having the Union flag in the upper canton next the staff, as in all British national ensigns. The "fly" bears the well-known circular identification mark borne by British Service aircraft, which became so familiar a sight to even the stay-at-home civilian during the War.

This honour—for honour it is, albeit one that has been well and truly earned by years of sacrifice in thousands of aerial combats—descends to the Air Force from the Royal Navy, with which it was, in part at least, very closely linked before and during the greater part of the War. The Army has no distinctive ensign of its own, though every infantry battalion, except the rifle regiments, has its colours in which the "King's colour" is the Union Jack. But that is not the same thing as the possession of a distinctive ensign, which has hitherto been the exclusive privilege of the sea services. The Royal Navy has the White Ensign, which is flown only by His Majesty's ships and shore stations belonging to the Navy, with the exception that vessels of the Royal Yacht Squadron have also the right to fly it. The Royal Naval Reserve has the Blue Ensign, which is also used by ships and vessels belonging to certain Government services, in the latter case adorned by a badge in the "fly" denoting the particular department to which they belong. The Red Ensign is the flag of the mercantile marine of Britain and the overseas Dominions. Ships belonging to British possessions fly it with the badge of the colony or dominion displayed as already described in the case of the Blue Ensign.

There is to us a double significance in this grant of a distinctive ensign to the Royal Air Force. Not only does it convey a sense of honour worthily earned and accorded, but it signifies also the separateness, if we may call it so, from the sister services of the Royal Air Force, and stamps it as one distinct in its duties and in its very element from both Navy and Army, though owing allegiance to a single ideal and devoted to a common task.

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A Growing Air Traffic The Air Ministry has taken a step in the right direction by the publication of tables—which we reproduce in full in another part of this issue of FLIGHT—showing the value of imports and exports to and from this country which have been carried by air transport during the period between August 26, 1919, and November 30, 1920. These statistics are in future to be issued monthly by the Air Ministry. Our readers will be able to analyse for themselves the figures contained in these very interesting tables, and all we need do here is to briefly refer to the totals with a view to showing that, in spite of all the handicaps under which civil aviation labours, some progress at least is being made, as is shown by the steadily increasing value of imports and exports. The most valuable index afforded by the figures is that which points to increasing public confidence in air transport as a means of forwarding valuable goods. We find that during the period under review the total value of aerial imports was £685,054, and of exports, including re-exports, £344,876. The volume of traffic, measured by value, carried during October and November last was about four times that carried during the same months of 1919, the imports having increased from £44,077 to £172,332, and exports from £22,987 to £109,831. The most prominent articles carried seem to be furs, jewellery, cinema films, clothing, perfumery, and mechanical components. The bulk of the imports came from France, whence large quantities of ladies' dresses, hats, hosiery, feathers, precious stones and so forth were conveyed to the value of £96,076 in October and £67,075 in November. The figures are both instructive and interesting, and we shall look forward to their monthly publication with added interest in the development of the cross-Channel traffic.

The Big Ship Controversy

We have naturally followed the controversy relating to the future of our Naval shipbuilding policy with more than a little interest, but the more we read the more are we reminded of the proverb which asks: "Who shall decide when doctors disagree?" It is practically impossible for the lay mind to arrive at anything like a settled opinion after reading the columns of print which are contributed to the daily Press by distinguished retired admirals and senior officers of the Navy, each one of whom appears to have his own ideas and conceptions of how the future sea wars will be fought and won.

The worst of it all is, from the point of view of the outsider who strives for enlightenment, that every letter he reads seems to smack of special pleading, an impression which is very often strengthened when the record of the writer is looked up and it is found that he is a distinguished specialist in the particular branch of the Service upon which he apparently pins his faith. Naturally, it is expecting a great deal when we ask the submarine specialist to admit that the future of naval war lies in the hands of the big ships. Nor is it logical to expect an officer whose principal service has been in battle ships to agree with the school which avers that the big ship cannot put to sea in the face of the submarine menace, and cannot even remain safely in harbour because of her vulnerability to attack by torpedo-carrying aircraft.

Hence the only way to arrive at conclusions is by a careful reading and weighing of all that is said on every aspect of the question, and a careful elimination of all that seems biassed by the known service and inclinations of the witness. The tendency we have in mind is well demonstrated by the fact, to which Admiral S. S. Hall draws attention in a letter to *The Times*, that the controversy has largely been reduced to a discussion of the respective merits of the battleship and the submarine. The share which aircraft are likely to take in the naval battles of the future, he points out, is ignored or dismissed with little more than a reference. Admiral Hall, after pinning his faith to "thoroughly efficient air, submarine and mining services," concludes his views with the very emphatic pronouncement: "*It is air mastery alone that can give us the power of a vigorous offensive.*"

General Brancker sums up the case quite well when he says—also in *The Times*—after reviewing the claims made by all sides: "Some writers have stated that the duty of the Fleet is to destroy the enemy's sea bases, coaling stations, fortifications and commercial harbours, and others have contended that submarines have rendered such enterprises impossible. But they will *not* be impossible to aircraft, and I am certain that, in the future, the Air Force must become *par excellence* the arm of offence against hostile commerce and territory. If this is admitted, then the proportion of the money available for armaments allotted to the Air Force as compared to the other services must be very high. If this high allotment to the Air renders the allotment to the Navy insufficient for the construction of capital ships, then they *must go*. No nation can neglect power in the air in order to preserve a form of defence so expensive in its maintenance and so problematical in its utility."

Naturally, we incline very much to the endorsement of Admiral Hall's and of General Brancker's views, and we believe that before many decades there will be few who will not be of the same way of thinking.

By way of a last "view" of the future the following sentence from a New Year's article in the German paper *Die Woche* should give food for reflection:—

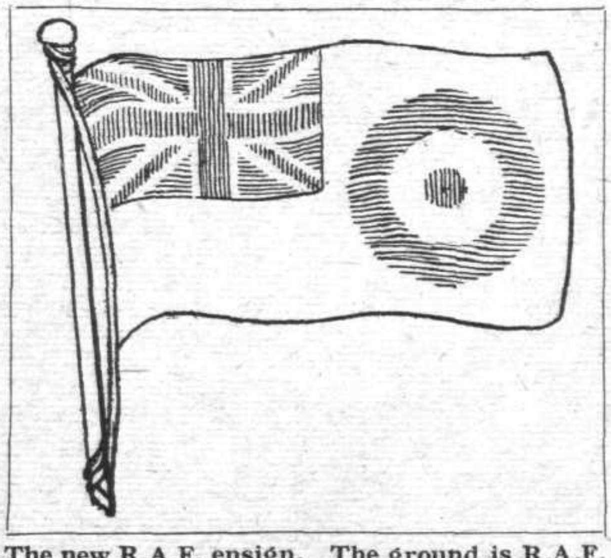
"The capability of ships to submerge marks a new era in the waging of warfare which is of the highest importance. It can never again be left out of calculation, any more than can the mastery of the air by airships and aeroplanes."

It would really seem to us that the matter has now arrived at a stage when it can best be judged by an able civilian committee, capable of sifting the whole of the evidence, etc., free from professional bias, and qualified to arrive at reasoned conclusions, which must be forced upon the professional seamen whether they agree with those conclusions or not.

THE ROYAL AIR FORCE ENSIGN

THE design for a Royal Air Force ensign has been approved by His Majesty the King. It consists of a flag of Royal Air Force blue, one-fourth of which is occupied by a Union flag as in the maritime ensigns. The fourth below the Union flag bears no device, whilst centred in the remaining half of the ensign is the Royal Air Force identification mark carried by all British Service aircraft.

The Union flag in the corner of the ensign denotes its nationality, whilst the colour and the marking serve to identify it as the ensign of the Royal Air Force. The inclusion of the Royal Air Force marking, which has become so familiar to all as the recognition mark on British Service aircraft, is appropriate in that it is the symbol under which many thousands of gallant actions have been fought in the air, and many thousands of British flying officers have been wounded or have met their death.



The new R.A.F. ensign. The ground is R.A.F. blue, and the rosette has the outer circle in Royal blue, the inner, white, and the centre, red.

The ensign will be flown daily from morning parade till sunset at the Headquarters of the Force, of areas and independent commands and at Royal Air Force Stations. Hoisted with due ceremony, it will be flown at the peak of a mast and gaff, at the masthead of which the distinguishing flag of the commanding officer will also be hoisted whenever the ensign is flown, except on those occasions when the Royal Standard or the personal Standard of a Member of the Royal Family takes the place of the distinguishing flag of the commanding officer, indicating that the King or a Member of the Royal Family is present.

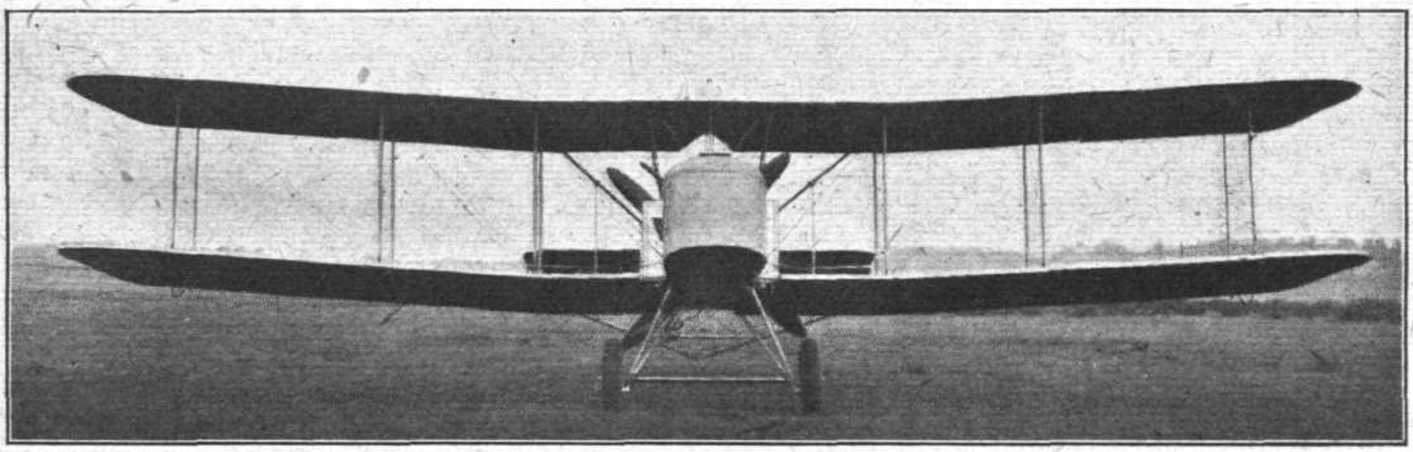
THE VICKERS "V.I.M." SCHOOL MACHINE

360 H.P. Rolls-Royce "Eagle" Engine

DURING the last two years or so the question of tuition has, it appears, been allowed to fall into the background. Yet this phase of the training of personnel is one of very great importance, whether viewed from the standpoint of military aviation, or in regard to commercial aviation of the future. That the question has not altogether been overlooked is, however, proved by the fact that at least one firm has quite recently produced a machine specially designed for school work. We refer to the new Vickers "V.I.M.," a photograph of which was published in FLIGHT recently. This machine, it will be seen from the accompanying illustrations, is of the "pusher" type, a type which has not been built during recent years, and the revival of which, for instructional purposes, is therefore of special interest.

Although the new Vickers "V.I.M." is designed for school work, this is not the only, nor perhaps the main, reason for designing her as a pusher. The object kept in mind was, we understand, that the new machine was to form a stepping-stone, as it were, to the Vickers "Vimy." The cockpits, etc., have therefore been arranged to reproduce, as far as possible, "Vimy" conditions, all necessary instruments and controls being provided for both pupil and instructor. Needless to say, a system of dual controls similar to that of the "Vimy" has been installed. Normally the pupil occupies the front cockpit, the instructor sitting close behind him in a separate cockpit.

Generally speaking, the new Vickers "V.I.M." resembles the old Vickers "Gun 'Bus" which did such a great amount of useful work during the earlier stages of the War. The power plant is, however, much more powerful than that of the earlier machine, being a 360 h.p. Rolls-Royce "Eagle," so that in this respect also the "V.I.M." approximates to the "Vimy." The advantage of this will be obvious. The pilot learns to know and to handle the single "Eagle" of the school machine before being faced with the extra complication arising out of the use of two engines in the larger machine. The fact that he has learned on a machine equipped with an engine of the same type reduces his difficulties to becoming used to twin-engine control, and avoids the trouble of having to deal with two unfamiliar engines.

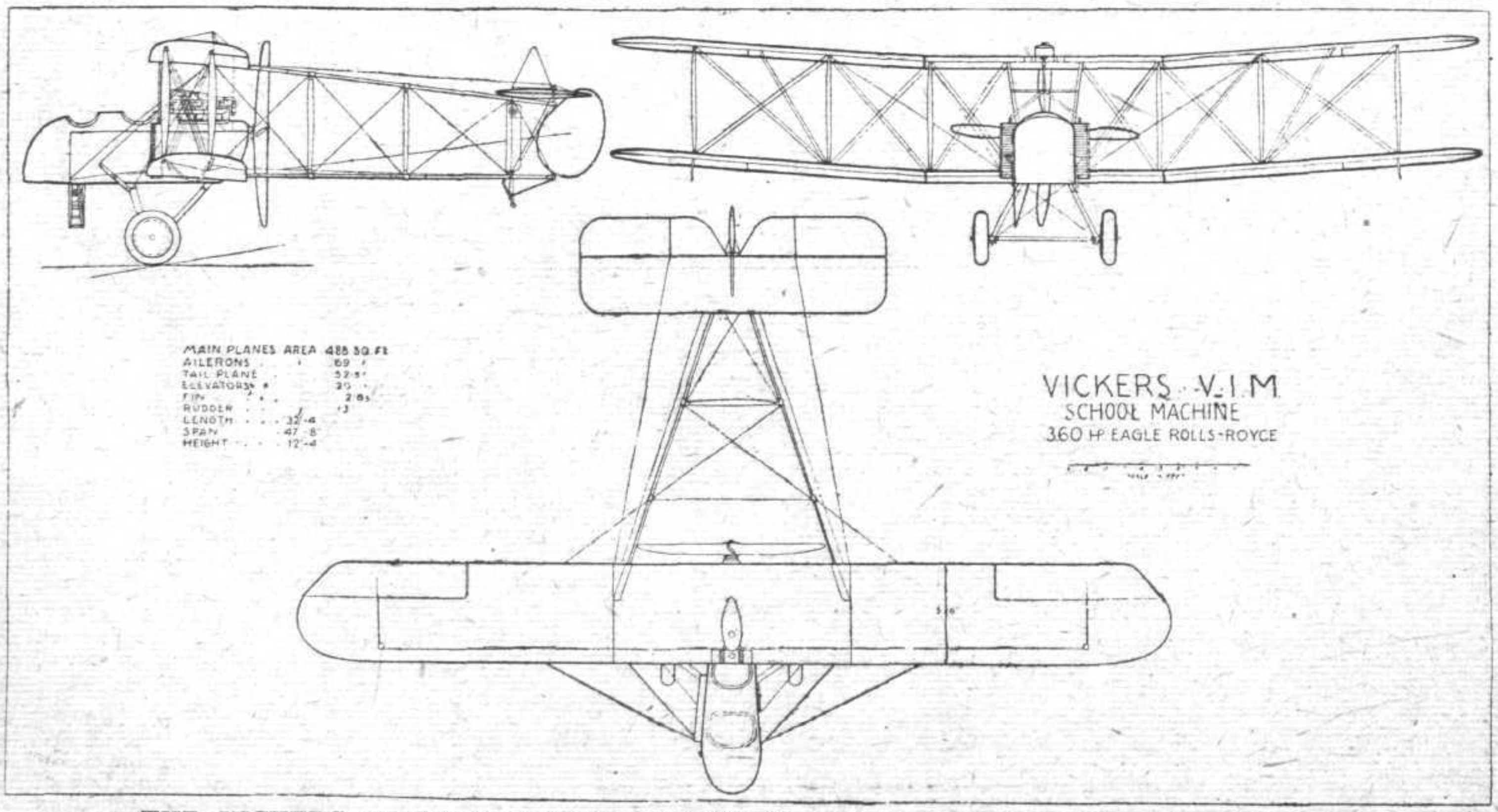


THE VICKERS "V.I.M." SCHOOL MACHINE: Front view.

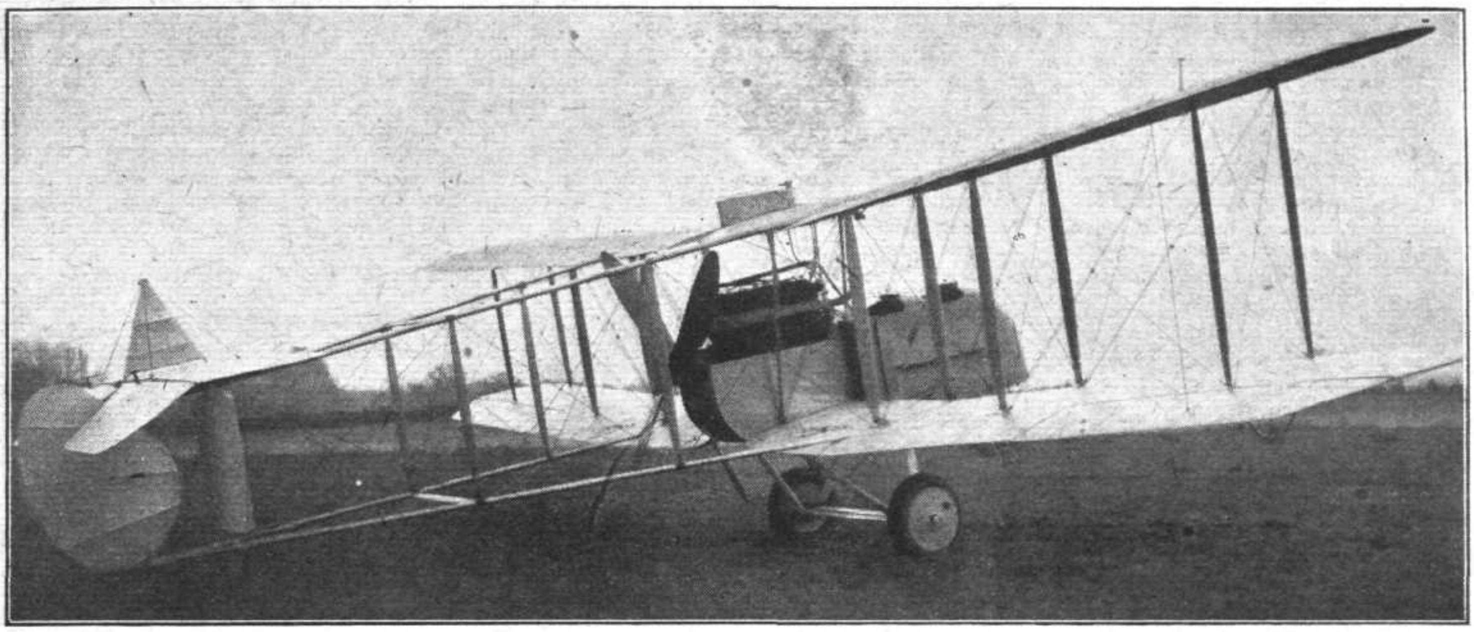
The following is a brief specification of the "V.I.M.":—

Constituent Weights

Machine empty with water ..	2,950 lbs.
Petrol (39 gallons)	281 ,,
Oil (6 gallons)	54 ,,
Pilot and pupil	360 ,,
Total weight	3,645 lbs.



THE VICKERS "V.I.M." SCHOOL MACHINE: Plan, side and front elevations to scale.



THE VICKERS "V.I.M." SCHOOL MACHINE: Three-quarter rear view.

General Dimensions

Overall length	32 ft. 4 ins.
Overall height	12 ft. 4 ins.
Overall span	47 ft. 8 ins.
Chord of main planes	5 ft. 6 ins.
Incidence of main planes, 4½ degs.; Dihedral, 4 degs.	
Area of main planes	488 sq. ft.
Loading per sq. ft., 7.5 lbs.; per h.p. (360), 10.4 lbs.	

Performance

Full speed near ground	100 m.p.h.
Time to 6,000 ft.	8.25 mins.
Full speed at 6,000 ft.	97 m.p.h.
Service ceiling	13,000 ft.
Endurance at 2,000 ft. at 80 m.p.h.	2¾ hours.
Landing speed	45 m.p.h.

THE ROYAL AIR FORCE MEMORIAL FUND

A MEETING of the Executive Committee was held at 7, Iddesleigh House, Caxton Street, S.W. 1, on December 16, at 3 p.m., Lord Hugh Cecil in the Chair. The Members of the Committee present were: Lady Leighton, Dame Helen Gwynne-Vaughan, Mrs. Barrington Kennett, Sir Charles McLeod, Air Vice-Marshal Sir John Salmond, Air Commodore Brooke-Popham, F. E. Rosher, Esq., and H. E. Perrin, Esq.

A list of donations and subscriptions received since last meeting, November 25, was submitted, and is appended. The Hon. Treasurer was authorised to sanction expenditure up to a sum of £1,000 in grants and allowances, without further reference to the Committee.

With reference to the proposed campaign in the provinces, for the collection of funds, the Secretary made a report on his six days' visit to Manchester and Liverpool, and it was reluctantly agreed, in view of the nature of his report, that all activities in this direction should be postponed until the Spring, in the hope that business and commercial activities would by then have become much better than they are at the present time. It was felt to be inopportune to put forward an appeal now.

The London County Council have approved of certain amendments to the rules of the Fund, whereby the scope of the Fund's activities are enlarged, chiefly in the direction of granting assistance to deserving cases which hitherto have not come within the rules of the Fund.

Further consideration was given to the R.A.F. Memorial, and a strong wish was expressed that this should be pressed forward with a view to an early settlement.

The scheme for the establishment of a Boys' Home at Vanbrugh Caste, Blackheath (the gift of Mr. Alexander Duckham), is being pressed forward and there is every hope of the Home being opened at Easter, next year.

A scheme of affiliation with Squadron or Unit Aid Societies was discussed, but a definite decision was postponed to a later meeting.

The next meeting of the Committee will be held on Friday, January 21, 1921, at 3 p.m. at the Offices of the Fund.

	£	s.	d.
Amount of donations and subscriptions announced up to November 24, 1920 ..	102,388	17	2
Amount since received, up to December 16..	358	13	8
	102,747	10	10

THE LONDON-CONTINENTAL SERVICES

LAST week (December 26, 1920-January 1, 1921) was again somewhat a slack one for the London-Continental Services. In all there were but ten flights, out of which but half were fully completed journeys. They were distributed over the various routes as follows:—Croydon-Paris, three Breguets carrying goods (one with mails in addition) left for Paris, but two landed at St. Inglevert, the third completing the journey in 2 hrs. 38 mins. Three Breguets also left Paris for Croydon with goods, one carrying a passenger; this latter machine landed at Dymchurch, Kent, but the other two completed their journey. The only other machine on this route was a Spad, with two passengers and goods, which completed the trip in 2 hrs. 45 mins.

Only one machine, a Handley Page, with five passengers and goods, left Cricklewood for Paris, which it reached in 3 hrs. 25 mins. Another Handley Page, with two passengers, goods and mails, left Paris for Croydon, but landed at Lympne.

No flights were made on the Cricklewood-Brussels route, but an Airco 9 (of Syndicat National pour l'Étude des Transports Aériens) with goods and mail, left Brussels for Cricklewood, but landed at St. Inglevert.

An Aeroplane Race for Brescia

IN connection with the automobile racing which is to take place at Brescia in September next, the Italian Aviation Society has decided to organise an event for aeroplanes. In an eliminating event the competitors will be classed according to the speed range capabilities, while the final contest will take the form of an endurance contest, probably over the same circuit as that used for the motor-race.

MONTHLY REPORTS OF IMPORTS AND EXPORTS BY AIR

THE Air Ministry makes the following announcement:—

The appended tables show the value of goods imported and exported by air during the months of October and November, 1920.

Similar tables will in future be issued monthly.

For the purpose of comparison, a summary is given of the figures for each quarter since the opening of air traffic with the Continent on August 26, 1919. From this date until the end of November, 1920, the value of all imports was £685,054, and of all exports (including re-exports) £344,876.

The volume of goods carried by air in October and November, 1920, was about four times that in the same two months of 1919, the imports having increased from £44,077 to £172,332, and exports (including re-exports) from £22,987 to £109,831.

Among the many different kinds of merchandise transported the most prominent are articles of clothing, furs, jewellery, kinema films, perfumery and mechanical components. The bulk of the imports came from France, where large quantities of ladies' costumes and dresses, as well as hats, hosiery, feathers, artificial flowers, precious stones, and goods of all kinds to the value of £96,076 in October and £67,075 in November were brought by air.

IMPORTS BY AIR
October-November, 1920

Period.	Free imports (from)					Dutiable imports (from)							Grand total.
	Belgium.	France.	Germany.	Nether-lands.	Total free.	Belgium.	France.	Germany.	Italy.	Nether-lands.	Switzer-land.	Total dutiable.	All countries.
1919	£	£	£	£	£	£	£	£	£	£	£	£	£
Aug.-Sept. ..	—	4,425	—	—	4,425	—	76	—	—	—	—	76	4,501
Oct.-Dec. ..	176	51,796	—	—	51,972	2	3,357	—	6	1	—	3,366	55,338
1920													
Jan.-March	208	71,397	—	470	72,075	5	4,197	—	—	—	—	4,202	76,277
Apr.-June ..	—	173,051	850	1,024	174,925	—	8,563	—	8,082	13	—	16,658	191,583
July-Sept. ..	229	175,672	—	869	176,770	398	7,617	—	200	38	—	8,253	185,023
Oct., 1920 ..	230	96,076	9	206	96,521	18	5,464	—	92	4	—	5,578	102,099
Nov., 1920 ..	929	67,075	—	21	68,025	1	2,009	3	—	3	192	2,208	70,233
TOTAL. Aug., 1919–Nov., 1920 ..	1,772	639,492	859	2,590	644,713	424	31,283	3	8,380	59	192	40,341	685,054

EXPORTS BY AIR
October-November, 1920

Period.	Exports: British (to)								Re-exports (to)				Grand total.
	Belgium.	Denmark.	France.	Germany.	Nether-lands.	Spain.	Other countries.	Total British exports.	Belgium.	France.	Nether-lands.	Total re-exports.	All countries.
1919	£	£	£	£	£	£	£	£	£	£	£	£	£
Aug.-Sept. ..	—	—	2,158	—	—	—	—	2,158	—	844	—	844	3,002
Oct.-Dec. ..	9,582	—	16,112	—	—	—	1	25,695	—	2,400	—	2,400	28,095
1920													
Jan.-March..	1	—	13,159	—	—	—	—	13,160	—	22,488	—	22,488	35,648
Apl.-June ..	—	—	20,842	—	2,585	50	—	23,477	113	36,639	853	37,605	61,082
July-Sept. ..	15,961	3,163	25,681	9	15,835	—	—	60,649	49	36,526	9,994	46,569	107,218
Oct., 1920 ..	7,098	933	41,936	—	7,076	—	26	57,069	138	9,748	4,522	14,408	71,477
Nov., 1920 ..	1,249	24	18,932	18	2,930	3	6	23,162	639	14,426	127	15,192	38,354
TOTAL. Aug., 1919–Nov., 1920 ..	33,891	4,120	138,820	27	28,426	53	38	205,370	939	123,071	15,496	139,506	344,876

Improving the London-Copenhagen Service.

AN endeavour is being made to substantially improve the air service between Copenhagen and London, according to Mr. Willie Wulff, Manager of the Danish Aeronautic Company. Up to the present it has been necessary for passengers to stay overnight in Amsterdam, but by the new arrangements there will be two trips from Copenhagen and London daily. Aeroplanes with passengers will leave Copenhagen and London early in the morning, arriving the same night at London and Copenhagen respectively, and machines carrying mails will leave London and Copenhagen at night, so that the mail will be distributed the next afternoon in the two capitals.

Sweden and Commercial Aviation

THE Swedish Customs authorities are now issuing monthly returns of aerial traffic. According to the October return 30 foreign aeroplanes arrived loaded and six in ballast, while 19 left loaded and 17 empty. It is stated in Stockholm that the Northern Aviation Co. has purchased four British aeroplanes, two of which will be flown across by Mr. Hawker and Major Johnstone respectively.

Air Liner as Ambulance

ONE of the Vickers-Vimy machines of the Instone Air Line was called into service as an aerial ambulance on January 3. Two paralyzed officers, Messrs. Bibby and Hayde, were not in a fit condition to travel to the Riviera by the ordinary method of boat and train, and the aeroplane was specially fitted for the journey. Travelling with the invalids were a doctor, a nurse, and an attendant, and with other passengers, two pilots, and a mechanic the number of people travelling was ten. During the whole of the time the machine was in the air wireless telephony was in progress. The first stop was at Paris.

CORRESPONDENCE

The Editor does not hold himself responsible for opinions expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters intended for insertion in these columns.

THE NAVY OF THE FUTURE AND AIRCRAFT

[**2037**] In the recent controversy on the trend of Naval development, widely-divergent views have been expressed. Some eminent authorities have asserted that all large surface craft should be abandoned owing to their vulnerability by torpedo attack, while others maintain that large ships can be built, doubtless at considerable extra cost, to safely withstand torpedo attack. It would appear, however, that these in their turn would be endangered by the advent of larger torpedoes carrying a heavier explosive charge.

In no case has the value of the torpedo as a weapon been questioned, and it is interesting therefore to consider the advantages which are claimed for aircraft over the other means which may be employed for delivering a torpedo attack, namely, small high-speed surface craft (ranging from motor-boats to destroyers) and submarines.

In attacking with the torpedo, as in all forms of attack, the element of surprise is of the utmost value. For this reason the submarine has an advantage over surface craft, in that it can approach close to its objective with little chance of detection until within short torpedo range. It pays a heavy price, however, for this advantage in its lack of speed and manœuvrability. Its lack of speed confines its operations largely to lying in wait for enemy ships, and if its presence is detected its poor manœuvrability gives the enemy a good chance of avoiding the torpedo by rapid changes of course. Surprise can rarely enter into an attack by surface craft; an approaching destroyer would be visible to the enemy in fairly clear weather for at least ten minutes before getting within extreme torpedo range, and, except in the case of opposing ships steaming towards one another, for a longer period.

Torpedoplanes flying at upwards of 10,000 ft. can begin to glide with engine off, and therefore silently, some ten miles away, remaining invisible until within three or four miles, and probably undetected until much closer. Gliding at say 120 knots it is unlikely they would be seen more than a minute before launching a torpedo at close range.

Thus the torpedoplane shares with the submarine the advantage of getting to close range unobserved, but on the score of speed and manœuvrability is not merely not inferior to its target, but has about four times the speed of a fast ship, and can turn in a time measured in seconds as compared with minutes. Moreover, with a fraction of the personnel of one submarine, a whole squadron of torpedoplanes can be provided to converge from all points of the compass, and so render manœuvres such as change of course almost useless.

The facility of getting to close range has not only the advantage of surprise, but also implies a much higher percentage of hits than can be hoped for with surface craft. When torpedoes are launched at a range of several miles, it is necessary in order to score a hit to estimate correctly the speed and course which the target will maintain or take up for some five minutes after the torpedo is discharged, and as change of course is commonly resorted to when a ship is attacked by torpedo, the percentage of hits to be expected is comparatively small.

From the point of view of cost, both as regards personnel and material, aircraft can claim a marked advantage. A flotilla of destroyers costing £300,000 or £400,000 each, and carrying 70 or 80 men each, would only in a heavy engagement average ten torpedoes discharged per ship. This would imply some seven or eight men and thirty or forty thousand pounds' worth of material employed and endangered for each torpedo fired. In the case of aircraft, there is only one man and a machine costing about five thousand pounds engaged for each torpedo fired. The implied assumption that each torpedoplane risked has an opportunity of discharging its torpedo is justified because it is not visible, and therefore not endangered, until within striking distance; moreover, every ship sighted, or whose position is signalled by wireless, presents an opportunity to a machine having a speed some 70 or 80 knots superior to that of any ship.

On the score of comparative results for the same cost, it is interesting to imagine what would have happened if in the battle of Jutland our destroyers had been replaced by torpedo-carrying aircraft of the same monetary value, some part of the ships of the line being used as carriers. If there were a hundred destroyers employed, costing, say, thirty-five million pounds, with crews aggregating 7,000 men, torpedoplanes could have been provided to the number of 7,000, which represents not less than 30 torpedoplanes to every ship in the German Fleet. The cost would have been the same, and the number of men endangered would have been the same, but whether any German ship would have returned to its harbour is another question.

As an illustration of the value of speed in torpedo work, it may be remarked that had this country been supplied with torpedo aircraft, as they now exist, at the time of the German naval raids on the East Coast, it would have been possible to give the Germans three hours' start on their return journey and still overtake them with torpedoes within an hour.

It has also to be borne in mind that at no time is an enemy fleet safe from attack by torpedoplanes. While a fleet may be protected from an attack by surface craft and submarines by being anchored in sheltered waters, the entrance to which is guarded by nets, mines and shore defences, such devices are no bar to aircraft, and while anti-aircraft guns may be installed, and fighter aircraft be sent up in opposition, these cannot be counted upon to stop more than a fraction of an attacking force.

R. BLACKBURN

Leeds, December 23, 1920

[For several years the Blackburn Company, of which Mr. R. Blackburn, A.M.I.C.E., A.F.R.Ae.S., is managing director, have specialised on torpedo aircraft, and have, in fact, built the whole of the machines of this class now in use in the British service. Mr. Blackburn's opinions of the value of the torpedoplane, therefore, carries considerable weight, and he points out that the design of these machines originated, as did so many excellent war machines, with Messrs. Sopwith, but was handed over to Messrs. Blackburns to put into production. A different engine was installed, and modifications were continually introduced as experiences were gained in what was a new, and still remains a highly specialised, branch of warfare.

Messrs. Blackburns' faith in the future of torpedo aircraft and their experience in the production of so many machines of this type naturally led to a desire on their part to produce a new machine incorporating all the improvements which had gradually been introduced in previous machines, and including several bold steps forward as regards general layout and construction. The machine which has been built and recently tested at their works at Brough, East Yorks, has completely fulfilled the firm's expectations. The torpedo carried is larger than in machines previously in service, the speed is greater, the rate of climb is better, and the ceiling higher. The engine employed to make this improved performance possible is the Napier Lion, which, on account of its light weight per horse-power, coupled with smooth and reliable running, is being so widely used in the present-day development of aircraft. The engine is carried on a mounting of steel tubes, which is arranged to leave the engine exceptionally accessible, and forms with the steel centre section of the machine a unit which from the engineering point of view is a marked advance on previous practice. The main planes are of orthodox construction, with spruce spars and steel struts braced with streamline wires, and the *fuselage* aft of the steel centre section is built of spruce with tie-rod bracing. The chassis is of novel design, and obviates several defects of previous divided chassis. This, together with the tail skid, has been severely tested during trials, and both have stood up satisfactorily to their work.

The following are the main particulars of the machine:—Span, 48 ft. 6 ins.; overall length, 34 ft. 10 ins.; height, 12 ft. 3 ins.; total weight, 6,300 lbs.; maximum speed, 100 knots; minimum speed, 45 knots.—ED.]

The Paris A.A. Defences

PARIS is determined to take no chances with the late enemy, at any rate as regards aerial matters. It has been decided to reconstitute and enlarge the anti-aircraft services of the city, and Parisians who are free from military services, are under the age of 55, and have good sight and hearing, are being called upon to volunteer for the duty.

Norway After Smugglers

IT has long been a troublesome business for the Norwegian Government to keep all the fjords round the coast under efficient observation, to prevent the smuggling of contraband goods into the country, but it has now been decided to organise an aerial police service to undertake the duty.

AIR MINISTRY NOTICES

(140) Air Navigation Directions Amendments: Authorised Patterns of Log Books to be used.

SECTION V of the Directions issued by the Secretary of State for Air, under the Air Navigation Regulations, 1919, and dated April 30, 1919 (Air Navigation Directions I), is cancelled, and the following provisions are substituted therefor:—

V. *Log Books*

1. The authorised patterns to which the log books shall conform in all essentials in accordance with paragraph 3 of Schedule V of the Regulations, are respectively the Journey Log Book (C.A. Form 26), the Aircraft Log Book (C.A. Form 27), and the Engine Log Book (C.A. Form 28), published by His Majesty's Stationery Office.

2. The log books shall contain all the information and particulars provided for in the authorised patterns referred to in the preceding paragraph, and the Instructions for Use set-out in the authorised patterns shall be complied with. The Sections of the journey log book headed "Navigation Log" need not, however, be fully entered up except when a navigator is carried on the aircraft, provided that in all cases sufficient details are entered in the column headed "Route" to enable the route followed by the aircraft to be clearly identified.

For the purpose of this paragraph the term "repairs" shall be deemed to include all overhauls, replacements, repairs and work of a like nature.

3. The constructor shall fill in and sign the original entries in the log books as far as he is in a position to do so. Subsequent entries shall be made and signed:—

(*a*) In the case of the journey and signal log book by the pilot, unless there is a commander of the aircraft other than the pilot, in which event the entries shall be made and signed by such commander;

(*b*) In the case of the aircraft and engine log books by the ground engineer; provided that as regards matters which could not have come to the notice of the ground engineer, the pilot shall be responsible for making and signing the entries.

4. All entries shall be made in ink, except in the case of journey and signal log books: the entries for these may be made in pencil in a rough notebook, but shall be entered in ink in the log book every twenty-four hours. In the event of any official investigation the rough notebook may be called for.

5. No erasures shall be made in, nor pages torn from, any log book.

(141) Fixed Balloon at White City, London

PILOTS are warned that a fixed balloon may be flown over the Ex-Service Men's Carnival and Exhibition at the White City, London (Lat. 51° 31′ 0″ N., Long. 0° 14′ 0″ W.), from December 24, 1920, to January 15, 1921.

NOTICE TO GROUND ENGINEERS

A NOTICE (No. 17) to Ground Engineers has been issued. It is in identical terms to the Notice (No. 140) to Airmen printed above.

ROYAL AERONAUTICAL SOCIETY NOTICES

Visit to National Physical Laboratory.—As announced in a special notice which is being circulated to every Member, arrangements have been made for a party of Members to be shown the work of the Aerodynamics Department of the National Physical Laboratory, Teddington, on Wednesday afternoon, January 26. Any Member who wishes to take advantage of this opportunity should send in his name to the Secretary on or before January 17 *at the latest.*

It is proposed to travel by the 1.56 p.m. train from Waterloo, (arriving at Teddington at 2.31 p.m.), and return by the 4.43 or 5.3 p.m. train from Teddington (arriving at Waterloo at 5.9 and 5.39 respectively).

Members of the party should obtain their own railway tickets and meet at the Laboratory, which is about five minutes' walk from Teddington Station.

Transactions.—A new volume on the "Transactions of the Royal Aeronautical Society" has just been published, and may be obtained at the Society's offices, price 5*s*. It embodies a paper on "Aero-Engine Efficiencies" by Dr. A. H. Gibson of Manchester University, which contains a large amount of important experimental data on the thermal efficiency of internal combustion engines.

Scottish Branch.—A section of this branch, under the title of "The Ex-Airmen's and Students' Section of the Royal Aeronautical Society" (Scottish Branch), has recently been formed in Glasgow for the purpose of providing students of Glasgow University and others with opportunities for discussing aeronautical questions. The Honorary Secretary is Mr. C. R. Catesby, "Highfield," Croxley Green, Herts.

W. LOCKWOOD MARSH,
Secretary

Personals

Married

Flight Lieut. FRANCIS EDWARD PHILIP BARRINGTON, R.A.F., only son of the late P. Sidney Barrington, of Cheeverstown, Clondalkin, Co. Dublin, and of Mrs. A. R. HYDE, of Streatham, was married on December 28 to ETHEL ROSE (FOXIE), second daughter of the late W. J. WOOD and of Mrs. WOOD, of Dulham.

Flight-Lieut. ROBERT A. G. ELLIOTT, R.A.F.M.S., eldest son of the late George Elliott, J.P., and Mrs. Elliott, of Arvagh, Cavan, was married on December 28 at St. George's, Hanover Square, to GEORGINA, second daughter of the late THOMAS EDWARD BAKER and the late Mrs. BAKER, late of Maythorne, Tenbury Wells, and niece of Charles G. Partridge, J.P., of Lambswick.

Major STANLEY SEWARD HALSE, late R.A.F., of Hughenden, Halseton, S. Africa, was married on November 22 at Queenstown, S. Africa, to ETHEL LOVEDAY, younger daughter of Mr. and Mrs. PERCY SPOONER-LILLINGSTON, of 4, Hoe Park Terrace, Plymouth.

Mr. WILLIAM DUNCAN FORBES LISTON, Indian Police, only son of Mr. and Mrs. Thomas Liston, of 111, Finchley Road, N.W., was married on December 20 at Colombo to NESTA SYBIL, widow of Capt. W. D. WAIN, R.A.F., and daughter of Mrs. R. Forrest, of New Court, Marlow.

Capt. KENNETH RONALD PATERSON, late R.F.C. and R.A.F., youngest son of Colonel and Mrs. A. M. Paterson, was married on December 15 to WEIL ELFRIDA CLOETE, only daughter of Lieut.-Col. and Mrs. CAPRON, of The Old Oak Lodge, West Drayton, Middlesex.

To be Married

The marriage arranged between Capt. GILBERT BARRETT, A.F.C., R.A.F., and Miss PHYLLIS CHURCHMAN will take place very quietly at Old Felixstowe Church, on Saturday, January 22.

The engagement is announced between ARTHUR CORFIELD GODFREY, late Middlesex Regt. and R.A.F., younger son of Mrs. L. Godfrey, of 29, Whittingstall Road, S.W., and MARY, the elder daughter of the Rev. H. E. and Mrs. WILSON, of Little Billing Rectory, Northamptonshire.

The marriage between Group-Capt. ROBERT GORDON, C.B., C.M.G., D.S.O., R.A.F., and ALISON MARGARET, only daughter of THOMAS ANDERSON, of The Grange, Monifieth, Forfarshire, will take place very quietly in January.

The engagement is announced of Squadron-Leader SIDNEY SMITH, D.S.O., A.F.C., R.A.F., son of the late Sidney Smith, of Lowestoft, and WINIFRED, only child of Dr. H. POOLE BERRY, O.B.E., T.D., and Mrs. Poole Berry, The Priory, Grantham.

The engagement is announced of Major HENEAGE GIBBES WHEELER, late R.A.F., of Bexhill-on-Sea, and FLORENCE Hayes, of St. Louis, U.S.A.

AIRISMS FROM THE FOUR WINDS

"I WOULD desire to impress on my countrymen the vital necessity of a Navy adequate for our protection at home and for the maintenance of the highways of the ocean for our trade and commerce. . . . It has always been a great power for peace. . . . I believe at the present moment that the Navy is both sufficient and efficient."

Thus Mr. Walter Long in a foreword to "Brassey's Naval and Shipping Annual" for 1921.

It would appear from such an expression from the First Lord that what is wanted therefore is intense concentration in commercial aviation as an economical and easy road to Air Force supremacy in the air. Possibly the hints at cutting down of the Air Estimates as well as the Army Estimates may indicate the forerunner of a real move in the direction of civil aviation as a conduit to an efficient Air Force.

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AT least a real effort is on the way in the utilisation for practical peace carrying experiments of the passenger airships R.36 and R.37—the work respectively of Messrs. William Beardmore and Co., Ltd., and Messrs. Short Bros.' Airship Factory at Bedford—which may quite well be ready for trial trips by the end of the month. About 50 passengers will be the complement for the first journey to the East, for whom sleeping-berths and other comfortable provision will be installed.

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ANOTHER "find" of German aerial material has been made and confiscated by the Fleet in Stettin. This, according to the *Volkszeitung fur Hinter Pommern*, was concealed in the grounds of Major von Fuchs, and consisted of undoubted secret Army stores. The goods were sent in large cases, 19 of which contained aeroplane motors, while 22 smaller cases were filled with aeroplane cameras. These cameras are said to be now practically unobtainable. The *Kösliner Volksblatt* says that the stores were hidden to protect them from the Entente.

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IT is this sort of thing which accounts for the anxious alertness of the French in regard to the machinations of the Germans, and justifies our Allies in their insistence that Germany should now, without further delay, be compelled to really carry out the disarmament requirements of the Peace Treaty. General de Castlenau, in urging instant action, has a sly thrust, with diplomatic moral, at Perfidious Albion in regard to the possibilities of future development. The General, in speaking to the point in the French Chamber, said the other day:—"No doubt we are not alone, but England, for her part, has secured safe guarantees in the destruction of the German fleet. What would be the position of France if some day she had not the valley of the Rhine between her and Germany? Have we told our British allies that the Germans are constructing guns and aircraft which menace even Britain herself? Have you shown the Allies the need for obtaining the integral execution of the Treaty of Versailles?"

By way of further emphasis M. Lefevre, the French ex-Minister of War, referred to a new ·77 gun which Krupp was manufacturing as late as last April, and of two new formidable machine guns, one for use against aeroplanes and one against tanks. So that it suggests more than ever there should be no longer any shuffling against provision for that "double or quits" day which is now so freely spoken of in Junker circles, as the aftermath of "Der Tag," which went wrong so badly.

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ADMIRAL SIR PERCY SCOTT has not been long in corroborating the realness of roofing in harbours against aircraft attacks as mentioned in last week's FLIGHT. In a further letter upon the much discussed problem, "Capital Ships or ——?" he tackles the belittlement by Admiral Waymouth of his suggestions in regard, *inter alia*, to the roofing in of harbours, and torpedoes to carry a ton of T.N.T. Dealing with the latter he states: "I have a drawing of one carrying a ton of T.N.T. She is steered from the air by wireless, and a high official connected with the Air Service (Torpedo Department) tells me that there is no limit to the size of a torpedo; that torpedoes can be controlled from the air; that in fact, they are at this moment controlling them from the air."

"MY other absurd suggestion," Sir Percy continues, "was in connection with roofed-in harbours. My friend Admiral Waymouth may not know that the Germans during the War roofed in harbours for their submarines. Admiral Waymouth may not know that the Admiralty during the War contemplated making roofed-in bomb-proof harbours for airships, and that these harbours were of a size more than sufficient to take on a battleship. This was kept a great secret; possibly the public and Admiral Waymouth have never until now ever heard of the idea. I ought to know a little about it because their lordships the Commissioners of the Admiralty ordered me to prepare the designs for these roofed-in harbours."

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ALL of which should be further inducement for the immediate speeding-up of the civil and commercial side of aviation to the ultimate good of the Empire's Royal Air Force.

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IT is significant that in a Bill to be shortly introduced into the U.S. Congress by the Fortifications Committee to make the Panama Canal impregnable against attack, possible danger from the air comes first.

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THATS a weird sort of police performance reported at Winnipeg by the Paris *New York Herald*. "After an aerial battle, in which machine guns were used with telling effect," so the statement runs, "Joseph Gadbury, an alleged confidence man, has been captured at Winnipeg. He is wanted in Iowa for obtaining £3,600 on a promise to build an aeroplane factory. He fled in an aeroplane. Detectives following him obtained the co-operation of the Canadian Mounted Police, who met Gadbury's aeroplane as it crossed the Canadian line and opened fire with machine guns. The battle was kept up until bullets from the police machine punctured the petrol tank and damaged the propeller of the fugitive aeroplane."

Upon mature reflection we think it safest to wait upon "further particulars."

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QUITE quaint and certainly very realistic was the installation by Messrs. Handley Page of an airship at the Hotel Victoria for the New Year's Eve festivities. That the affair was no make-believe may be gathered from the fact that the gasbag was 80 ft. by 13 ft. And at the mystic hour of twelve there were "surprises" for the guests emanating from the cabin.

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So D'Annunzio, the Italian fanatic poet-aviator, has at last seen reason and agreed to an "armistice." It was characteristic of this mistaken patriot that he should have taken note of the last operations over Fiume from an aeroplane, and should have again distributed further literature from on high. His mad heroics must have cost his country and his fellows a good deal and maybe he will now be able to ease off his superfluous energy through his other hobby, and so help forward the problem of practical aviation.

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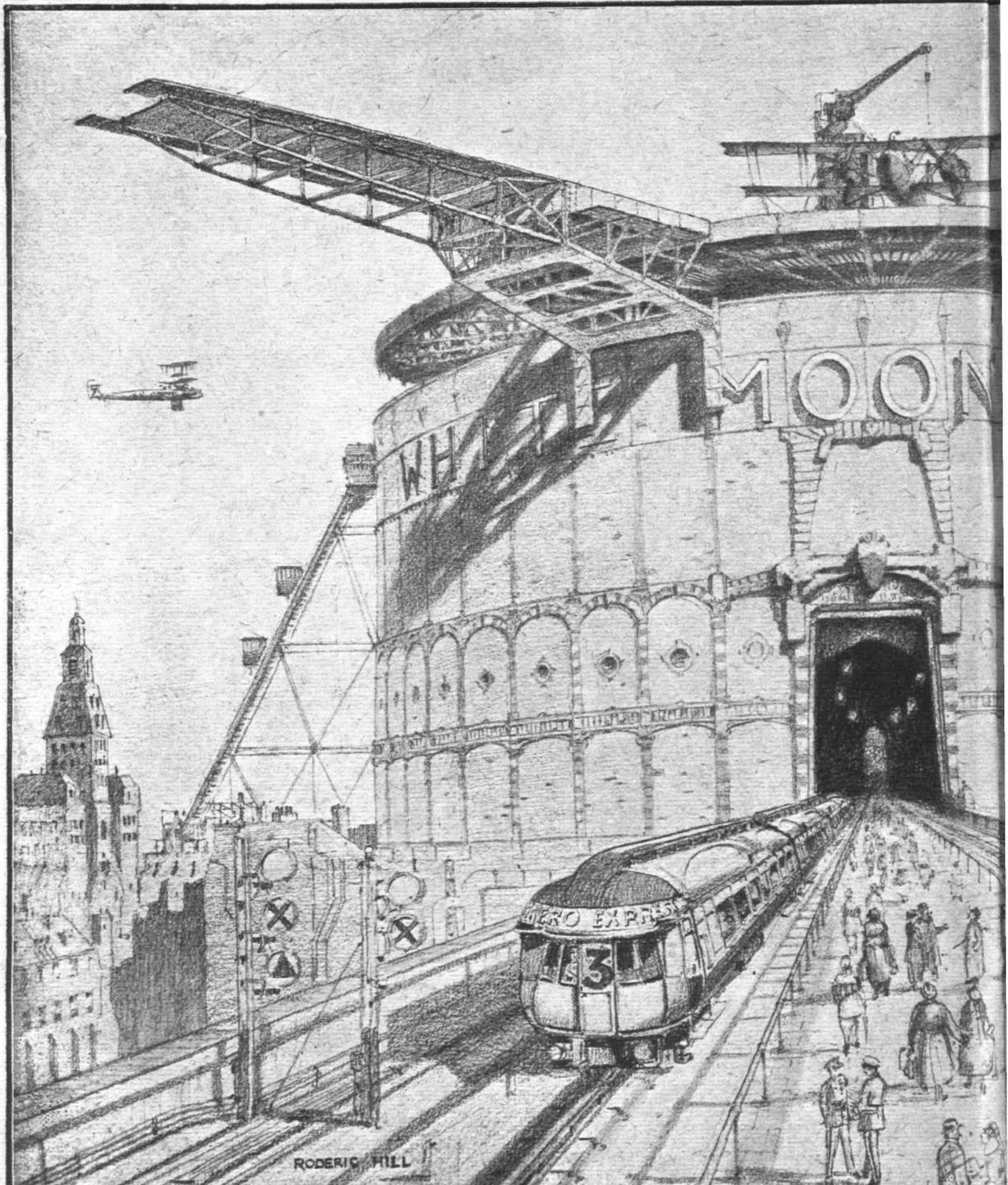
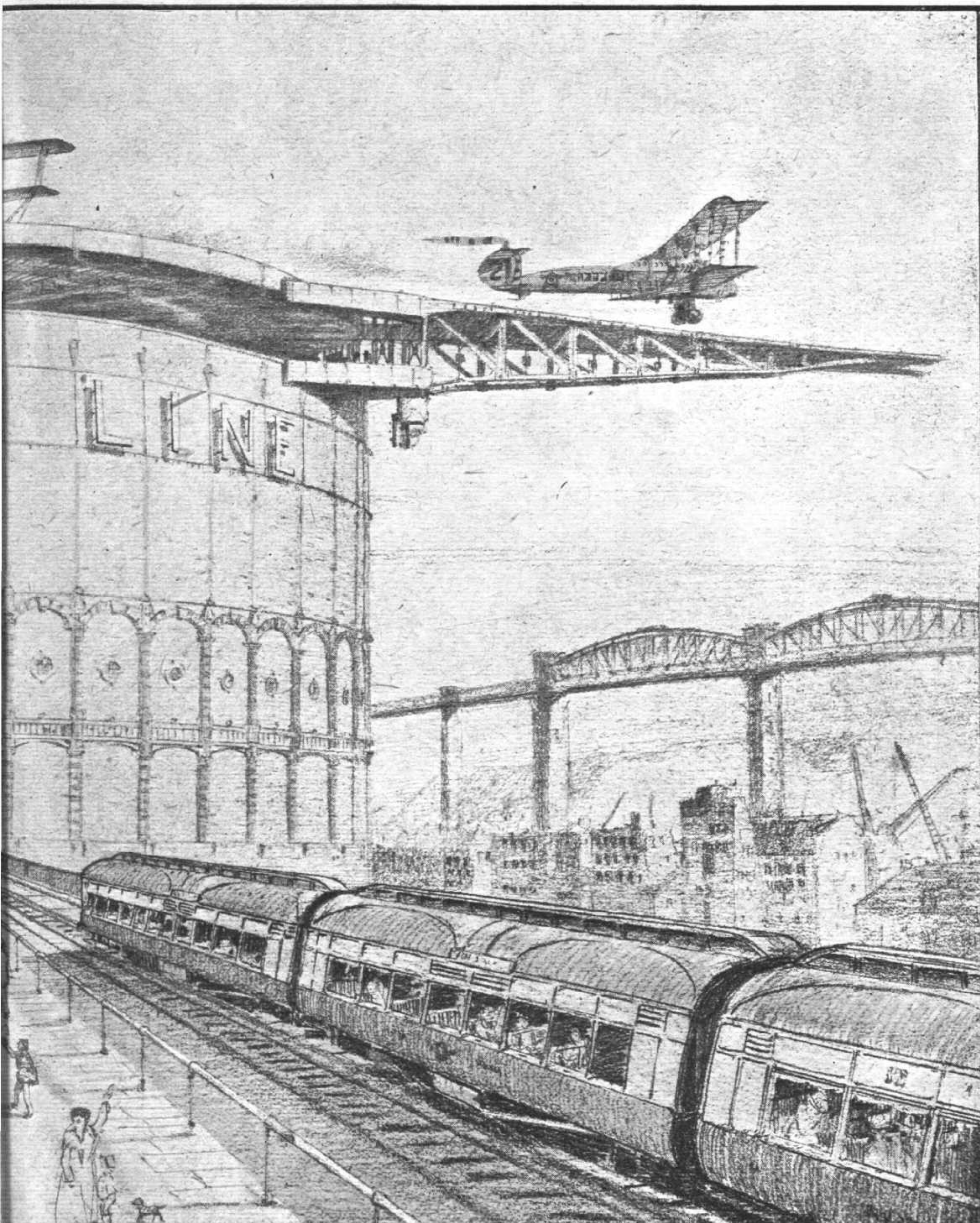
MORE air-post stamps for the philatelist to mark down for inclusion in his set are noted by Mr. F. J. Melville. He states that Hungary issued two surcharged stamps during the War, on July 4, 1918, for use on correspondence sent by an experimental air mail. These were the 1.50 krone and 4.50 krone stamps, which we have already described. The War service only lasted a few weeks, and was abandoned on July 24, 1918, after several accidents to the aviators. Now the development of trans-Continental air services has led the Hungarian Government to provide some new stamps for use on air mails. These have been created by surcharging new values on the 10 kronen violet-brown "Parliament" stamps of 1916–17 (inscribed "Magyar Kir. Posta"). In addition to the new value the words "Legi Posta" are overprinted. The values and colours of the overprints are: 3 kronen in green on 10 kronen, 8 kronen in red on 10 kronen, 12 kronen in blue on 10 kronen.



"TRAVELLING OF THE FUTURE: THE BRITISH AERIAL TERMINUS OF THE WHITE MOON L
possibilities, are becoming visible. When the stricken nations return to a state of prosperity, great things a
the most daring of us hesitates to speculate. The picture shows an aerial terminus of the White Moon
its topmost circumference platforms swinging on a circular railed bed are carried by two rotating arms,
changes, so that the aero liners descend and ascend facing it. These arms are inclined a little d
gather speed more rapidly before the final breathless abandonment of the sloping platform and the upward
carrying passengers to and from the high embarking level. A mono-railway penetrates to the heart of the t
journey; another is stationary, loading up. Inside the structure is a huge lift for lowering the aero liners for
where hundreds of mechanics work busily day and night . . . Perhaps some of the future aerial termini
such as this. The sea-captains will look upwards at the air-captains, beholding the fulfilment of a great
such great things would come to pa



NE."—The old order is passing. Already glimpses of the future of aerial transport, with all its mighty
e in store. As to what economic and commercial revolutions are latent in the development of flying,
ine, raised aloft over a seaport. This is no flat aerodrome, but a huge circular structure. Around
which the aero liners alight and from which they ascend. The arms are moved round as the wind
wnwards to bring the liners more quickly to rest—they alight up the slope—and to assist them to
sh into the heavens. On the left is seen a passenger lift with two cars which rise and sink continually,
minus ; a footway runs between the tracks. An aero liner is seen just ascending, bound on some far
efitting and repair, and in its mysterious depths we can picture workshops lit by flickering arc lamps,
l be on the ground ; but where a man can find no ground near the starting place, he will raise structures
eam, dreamt by generations of wise men long passed away, who wondered because they knew that
. *From the original by Roderic Hill.*

CAMBRIDGE UNIVERSITY AERONAUTICAL SOCIETY

(OFFICIAL ORGAN, "FLIGHT")

AEROPLANE DESIGN *

Some Present and Future Possibilities

By Captain F. S. BARNWELL, B.Sc., O.B.E., A.F.C., F.R.Ae.S.

Drag.—"The first thing to consider is the load-carrying power of the aeroplane. In horizontal flight at some uniform velocity, propeller thrust is equal to total drag, and total lift is equal to total weight. It is convenient to divide up and consider the total drag into three parts :—Drag of wing surface alone, which I shall call 'Wing Drag' and denote by r_W; drag of tail plane with elevator flaps, fin, and vertical rudder, which I shall denote by r_S; and drag of *all* the rest of the machine, which I shall call 'Residual Drag' and denote by r_R. Probably the optimum lift over drag for wing surface of full-sized aeroplane is about 25 to 1. Therefore we must have a drag at least one-twenty-fifth of the total weight. The Stabilising Drag also has some fairly definite minimum value, probably we cannot get below about 12 per cent. of the wing drag. Therefore, simply to maintain the aeroplane at a constant height in a stable and controllable condition, we must have a drag of at least one-twenty-second of the total weight. The Residual Drag, however, is a much more variable quantity, and offers far greater possibilities of improvement.

Item Weights

"The total weight is best considered as made up of: (A) Aeroplane structure; (B) power plant complete (dry); (C) fuel, oil and water (if required) and necessary tanks; (D) weights more or less constant, *i.e.*, flying and engine controls, instruments, seating and windscreen; (E) useful load; (F) the pilot. Of these weights (B) is, at present, the most variable. From the point of view of ton-miles-per-gallon efficiency, the lower the power the higher the efficiency. Probably the low limit for power in commercial aeroplanes is fixed more by considerations of 'get-off' qualities than by anything else. Probably one can say that, with present conditions, it is not sound to go below 1 h.p. per 20 lbs. of total loaded weight. An average figure for weight per b.h.p. of modern aero engines is 2.7 lb., and an average figure for weight per b.h.p. of total power plant (dry) is 3.3 lb. This gives us therefore a minimum for total power plant (dry) of about .165 lb. per lb. of total loaded weight, or 16½ per cent. Our best aero engine practice at present gives petrol consumption of .55 pint per b.h.p. per hour, and oil consumption of about .023 pint per b.h.p. per hour. Cooling water may fairly be taken as directly proportional to the b.h.p., an average figure being .023 gallon per b.h.p. This amount is a minimum, and in practice it has been found necessary to add a *constant* amount of one gallon. Also to add an amount equal to some constant times b.h.p. × hours' duration, an average figure being $\frac{H \times N}{1600}$ in gallons, where H is the numerical value of the b.h.p. and N is the numerical value of flight duration in hours. This gives a total weight of fuel, oil and water of $10 + 23\ H + .5298\ (H \times N)$, in lbs. For a machine with b.h.p. equal to one-twentieth of total loaded weight we get total weight, in lbs. of fuel, oil and water $= 10 + .0115\ W_T + .02649\ (W_T \times N)$, where W_T is the total loaded weight in lbs. and N the duration in hours. Neglecting for the moment the constant weight of 10 lbs., which is of importance in quite small machines only, we see that for a duration of one hour, total weight of fuel, oil and water = about 3.8 per cent. of W_T; for two hours about 6.45 per cent.; 3 hours 9.1 per cent.; 4 hours 11.75 per cent.; 5 hours 14.4 per cent.; 6 hours 17.05 per cent., and so on. The weight of tanks will be considered more fully later, but in the meantime a fair average figure is 11 per cent. of the weight of their contents. Approximately then, weight of fuel, oil and water and weight of necessary tanks for fuel and oil amount to :—

4.1	per cent. of W_T	for	1	hour's duration.
7.05	,,	,,	2	,,
10	,,	,,	3	,,
12.95	,,	,,	4	,,
15.9	,,	,,	5	,,
18.85	,,	,,	6	,,

and so on.

Airscrew Weight

"With regard to the airscrew, assuming that form and material be kept constant, the weight will vary as the cube of the diameter. Assuming in addition that the speed of revolution and speed of translation be kept constant, the h.p. absorbed will vary as the fourth power of the diameter. Further, if the speed of translation vary, and the pitch *only* of the airscrew be varied, so that the ratio of pitch to advance per revolution be kept constant, the h.p. absorbed will vary approximately directly as the speed of translation.

"The curves in Fig. 1 are for a speed of translation of 100 m.p.h. and for a speed of revolution of 1,170 r.p.m., and represent good average practice for a 4-bladed screw made of Honduras mahogany; 100 m.p.h. has been chosen as a useful speed for commercial machines, and as being the

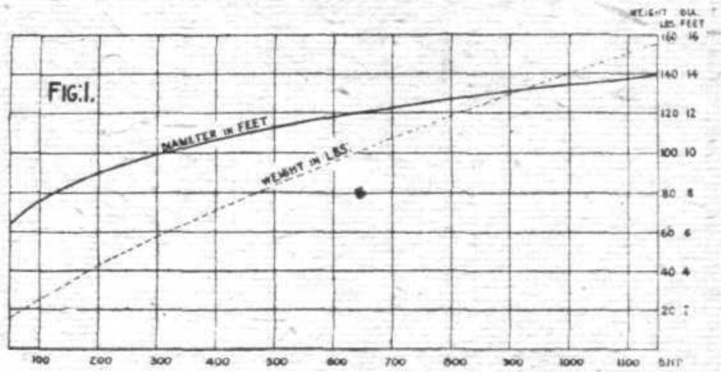


Fig. 1 : Curves for diameter and weight of four-bladed mahogany airscrew on base of b.h.p., for constant revs. (1,170 per min.) and constant speed (100 m.p.h.). Weight in lbs. = ·0578 D^3, where D is diameter in feet. B.h.p. absorbed at 1,170 r.p.m. and 100 m.p.h. is ·0307 D^4, and varies as V.

speed attainable on a power loading of 20 lb./b.h.p. with a wing loading of 8 lbs./sq. ft.; 1,170 r.p.m. represents the airscrew revolutions given by the reduction gear of the Rolls-Royce 'Falcon' when the crankshaft is turning at 2,000 r.p.m., the revolutions for maximum normal power.

Constant Weights

"The weights which are more or less constant for any aeroplane with single control can be taken as :—

	lbs.
Aileron and elevator controls	9·7
Rudder control	3·5
Tail plane control	8·0
Throttle control..	2·5
Magneto control	1·5
Altitude control..	1·5
Radiator shutter control	1·6
Switches and wiring	2·7
Starting mag. and mounting	7·2
Dashboard and all engine and navigating instruments	16·0
Pilot's seating	12·0
Engine doping system	4·0
Cocks, pumps, filter, etc., of petrol and oil systems	8·8
Pilot's windscreen	2·0
Total	81·0

"One other small item, which is not included in above table of controls, is weight of control cables, which can be taken as varying directly as the linear-dimension of the aeroplane.

Wing Weights

"I have divided the weights of the structural members up into :—Weight of complete wing structure W_g, of complete *fuselage* w_F, of complete tail unit w_T, and of complete undercarriage w_U. For convenience I have considered these weights as functions of the wing chord in feet, denoted by C. The various equations for structural weights, which I shall give presently, are based on the detail weights of the 'Bristol Fighter,' whose strength has been calculated and checked particularly fully, and in the structure of which little weight

* Extracts from paper read on December 1, 1920.

has been wasted. This machine is a biplane with two-bay wings and planes of equal span and chord, *i.e.*, 39 ft. 4 ins. and 5 ft. 6 ins. respectively. The gap is 5 ft. 4 ins. and positive stagger 20 ft. The principal areas are as follows :—Total wing area, 404 sq. ft.; tail plane, 26.; elevator flaps, 22·5.; top fin, 6·9.; bottom fin, 3·8; and rudder 7·2 sq. ft. The total wing area, therefore, $A_w = 13 \cdot 36\ C^2$, or $C = \cdot 08652\ \sqrt{A}$. The total wing weight is 362 lbs. The maximum permissible loaded weight, W_T, for this machine is 3,230 lbs., meaning that the maximum permissible wing-stressing load, W_s, is $3{,}230 - 362 = 2{,}868$ lbs., or 7·1 lbs./sq. ft. If we alter the scale of the wings throughout, the stress loading will remain the same *per sq. ft.*, whilst the wing weight will vary as the cube of the chord C. But it is impracticable to alter the scale throughout. Thus the wing covering is the same for all sizes of machines, and amounts to about ·14 lb./sq. ft. of *wing* surface. Main spars, internal compression members, metal fittings, internal and external bracing wires will all vary as the cube of the chord.

Streamline Struts

"The external wing struts will vary as the cube of the chord so long as they are of the same form, but in small sizes they are made solid, while in larger sizes they may be made hollow, and increasingly hollow as the size increases. Assume that, on the cross section of a hollow strut, the internal outline is of the same form as the external outline. Let B represent the maximum breadth of the external outline, and b that of the internal outline. Also, let B_1 represent the maximum breadth (of outline of section) of a *solid* strut with cross section of same form, and of same moment of inertia, as that of the hollow strut. Then :—

$$\begin{aligned} \text{If } b &= \cdot 6B \text{ then } B = 1 \cdot 035\ B_1 \\ ,, \ ,, &= \cdot 7B \quad ,, \quad ,, = 1 \cdot 071\ B_1 \\ ,, \ ,, &= \cdot 8B \quad ,, \quad ,, = 1 \cdot 141\ B_1 \\ ,, \ ,, &= \cdot 9B \quad ,, \quad ,, = 1 \cdot 307\ B_1 \end{aligned}$$

and when

$$\begin{aligned} b &= \cdot 6B, \text{ area hollow section} = \cdot 686\ A_1 \\ ,, &= \cdot 7B, \quad ,, \quad ,, \quad ,, = \cdot 585\ A_1 \\ ,, &= \cdot 8B, \quad ,, \quad ,, \quad ,, = \cdot 469\ A_1 \\ ,, &= \cdot 9B, \quad ,, \quad ,, \quad ,, = \cdot 324\ A_1 \end{aligned}$$

where A_1 = area of cross section of solid strut of same moment of inertia.

"The external, or tween-wing, struts are 'long' struts, and their strength is directly dependent upon the moment of inertia of cross section, meaning that the hollow struts quoted above should be of the same strength as the equivalent solid ones. We see, therefore, that we can save up to nearly 68 per cent. in weight by hollowing. But as a hollow strut needs a certain amount of external binding, and must have solid ends it is probable that a safe assumption is that 50 per cent. is the maximum that can be saved by using hollow struts. I have assumed, therefore, that solid struts are used up to $C = 6 \cdot 2$ ft.; that 25 per cent. of weight (for solid struts) is saved (by hollowing) from $C = 6 \cdot 2$ ft. to $C = 6 \cdot 7$ ft.; 30 per cent. from $C = 6 \cdot 7$ to $7 \cdot 2$; 35 per cent. from $C = 7 \cdot 2$ to $7 \cdot 7$; 40 per cent. from $C = 7 \cdot 7$ to $8 \cdot 3$; 45 per cent. from $C = 8 \cdot 3$ to $9 \cdot 0$; 50 per cent. for all sizes above $C = 9 \cdot 0$.

"The wing ribs, nosing ribs, leading and trailing edges, tip edgings and spacing battens are all parts which cannot remain strictly to scale for all sizes. I have, therefore, made some distinctly empirical assumptions about the weight of these parts. I have taken those of the Bristol 'Fighter' as being the basic weight for C value of 5·5 ft., and have assumed that for all values of C *below* 7·7 ft. the weight varies as C^2, while for all values of C *above* 7·7 ft. the weight then proceeds to vary as C^3.

Wing Weight Equations

"From the foregoing we obtain a series of 7 equations for wing weight expressed as functions of wing chord, each equation referring only to definite limits of chord length.

$$\begin{aligned} 1 \cdot 466\ C^3 + 3 \cdot 888\ C^2 &= W_w \quad \text{for} \quad C < 6 \cdot 2 \text{ ft.} \\ 1 \cdot 400\ C^3 + 3 \cdot 888\ C^2 &= W_w \quad 6 \cdot 2 < C < 6 \cdot 7 \ ,, \\ 1 \cdot 386\ C^3 + 3 \cdot 888\ C^2 &= W_w \quad 6 \cdot 7 < C < 7 \cdot 2 \ ,, \\ 1 \cdot 373\ C^3 + 3 \cdot 888\ C^2 &= W_w \quad 7 \cdot 2 < C < 7 \cdot 7 \ ,, \\ 1 \cdot 589\ C^3 + 2 \cdot 119\ C^2 &= W_w \quad 7 \cdot 7 < C < 8 \cdot 3 \ ,, \\ 1 \cdot 576\ C^3 + 2 \cdot 119\ C^2 &= W_w \quad 8 \cdot 3 < C < 9 \cdot 0 \ ,, \\ 1 \cdot 563\ C^3 + 2 \cdot 119\ C^2 &= W_w \quad C > 9 \cdot 0 \ ,, \end{aligned}$$

where W_w = total wing weight, in lbs.; C = wing chord in feet, and $A_w = 13 \cdot 36\ C^2$, in sq. ft.

"These equations refer strictly to wing weights for a two-bay biplane of the *proportions* of the 'B.F.' They will, however, not be very far from accurate for biplanes of other proportions, provided that the basic numerical value of C be taken as $\sqrt{\frac{A}{13 \cdot 36}}$, *not* as the real chord length.

Fuselage Weight

"We come now to consider the weight of the *fuselage*. By 'fuselage' I mean only the girder structure complete with its covering.

"The fuselage also is a structure, which, if perfectly designed throughout, should remain exactly to scale in all its parts. For manufacturing and other reasons, it cannot do this. I have taken as basic figures the weights of the 'Bristol Fighter.' In this machine the *fuselage* is 18·1 ft. long, 2·73 ft. wide, and 2·95 ft. deep. It weighs 143 lbs., composed as follows :—

4 longitudinals, 23·1 lbs.	Wood fairing, battens, formers, etc., 11·3 lbs.
All struts, 31·4 lbs.	Sheet aluminium covering, 13·2 lbs.
Plywood, decking and flooring, etc., 20·5 lbs.	Fabric covering complete, 12·0 lbs.
All metal fittings, 20·3 lbs.	
All bracing tie-rods, 11·0 lbs.	

"I have retained as a basic figure, C, the wing chord—C being of course of numerical value 5·5 for this basic *fuselage* of 143 lbs. weight. I have then assumed that :—Fabric covering, 3-ply decking and flooring and one-half of the weight of wood fairing and sheet aluminium covering, vary as C^2. All metal fittings and tie rods and the other half of the weight of wood fairing and sheet aluminium covering vary as C^3. Longitudinals and struts vary as C^3, but that beyond certain value of C weight can be saved by hollowing these.

"Now the longitudinals and struts of a *fuselage* must be regarded as 'short' struts, and their strength determined by the Rankine-Gordon formula

$$P = \frac{f_c \times A}{1 + C \left(\frac{L}{K}\right)^2}$$

Taking $f_c = 5{,}000$ lbs. per sq. in., constant C as $\frac{1}{3000}$, and a value for $\frac{L}{K}$ of 90, we get $P = 1{,}350$ A for a square section solid strut of length equal to 26 times its thickness; K for a solid square section being equal to $\cdot 289t$. If we substitute a square section hollow strut, with a square section bore, and wall thickness equal to one-tenth of the strut siding :—Cross sectional area $A = \cdot 36t^2$. Radius of gyration, $K = \cdot 37t$.

"We find that we must make the siding of this hollow strut about 1·25 times that of the equivalent solid strut to get the same ultimate strength, and the *weight* of the hollow strut will be about 56 per cent. of that of the solid.

"I have made the following approximations for possible lightening due to hollowing of longitudinals and struts; no hollowing is practicable up to $C = 6 \cdot 2$; 20 per cent. of weight can be saved for values of C between 6·2 and 6·7; 25 per cent. for values between 6·7 and 7·2; 30 per cent. between 7·2 and 7·7; 35 per cent. between 7·7 and 8·3; 40 per cent. for all values of C greater than 8·3.

"From the foregoing are obtained five equations for total weight of *fuselage* —

$$\begin{aligned} W_F &= \cdot 5893\ C^3 + 1 \cdot 479\ C^2 \qquad C < 6 \cdot 2 \\ ,, &= \cdot 5238\ C^3 + \quad ,, \qquad 6 \cdot 2 < C < 6 \cdot 5 \\ ,, &= \cdot 5075\ C^3 + \quad ,, \qquad 6 \cdot 5 < C < 7 \cdot 2 \\ ,, &= \cdot 4907\ C^3 + \quad ,, \qquad 7 \cdot 2 < C < 7 \cdot 7 \\ ,, &= \cdot 4744\ C^3 + \quad ,, \qquad C > 7 \cdot 7 \end{aligned}$$

Weight of Tail

"The weight of the tail unit W_T is much the same problem.

"I have again taken the basic weight for this element from the 'Bristol Fighter,' and obtained two equations in terms of wing chord C.

$$\begin{aligned} W_T &= \cdot 2446\ C^3 + \cdot 5587\ C^2 \text{ for } C < 7 \cdot 7 \\ ,, &= \cdot 2764\ C^3 + \cdot 314\ C^2 \quad ,, \ C > 7 \cdot 7 \end{aligned}$$

Landing Gear Weight

"The last structural element is the landing gear, consisting of main undercarriage and tail skid. In the 'Bristol Fighter' the complete undercarriage weighs 97 lbs and the tail skid 10 lbs., a total of 107 lbs. for the landing gear of a machine of 3,230 lbs. weight, or ·0331 of the total weight. I have assumed that weight of landing gear varies directly as total weight of aeroplane and is of this value, ·0331. I am not certain that this assumption is entirely sound, but it possesses at least the merit of simplicity.

"We have now got the following *equations for the total*

weight of wing structure, equivalent fuselage and equivalent tail unit, in lbs., i.e., $W_W + W_F + W_T$:—

$2{\cdot}2999\,C^3 + 5{\cdot}9257\,C^2$ for all below $C = 6{\cdot}2$
$2{\cdot}1684\,C^3 + 5{\cdot}9257\,C^2$ from $C = 6{\cdot}2$ to $C = 6{\cdot}7$
$2{\cdot}1381\,C^3 + 5{\cdot}9257\,C^2$ „ $C = 6{\cdot}7$ to $C = 7{\cdot}2$
$2{\cdot}1083\,C^3 + 5{\cdot}9257\,C^2$ „ $C = 7{\cdot}2$ to $C = 7{\cdot}7$
$2{\cdot}3398\,C^3 + 3{\cdot}9120\,C^2$ „ $C = 7{\cdot}7$ to $C = 8{\cdot}3$
$2{\cdot}3268\,C^3 + 3{\cdot}9120\,C^2$ „ $C = 8{\cdot}3$ to $C = 9{\cdot}0$
$2{\cdot}3138\,C^3 + 3{\cdot}9120\,C^2$ for all above $C = 9{\cdot}0$

Equations for Constant Weights, Power Plant (dry), Landing Gear and Control Cables

Constant Weight, $W_K = 81$ lbs. W_K includes flying and engine controls (including starting mag., switches, and wiring, and doping system), instruments, pilot's seating, wind screen, pumps, cocks, etc., of petrol and oil systems.

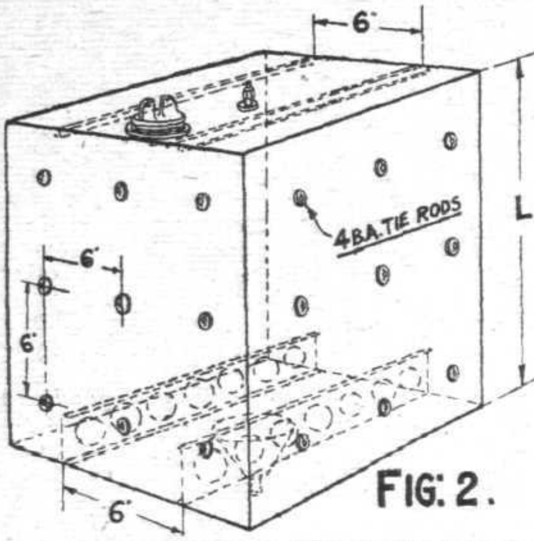


Fig. 2 : Cubical tank in 22 S.W.G. tinned mild steel : Weight in lbs. (empty) $W = 1 + 1{\cdot}3\,L + 7{\cdot}7\,L^2 + {\cdot}4\,L^3$. Capacity in gallons $= 6{\cdot}2\,L^3$, L being, in both cases, length of side, in feet. Fuel, Oil and Water : Petrol consumption, ·06875 gallon per b.h.p./hour or ·497 lb. per b.h.p./hour. Oil consumption ·00288 gallon, or ·0265 lb. per h.p./hour. Cooling water $1 + {\cdot}023\,H + \frac{H \times N}{1600}$ in gallons ; where H = max. b.h.p. and N = duration in hours. W_P, total weight of petrol, oil and water, $= 10 + {\cdot}23\,H + {\cdot}5298\,(H \times N)$, in lbs.

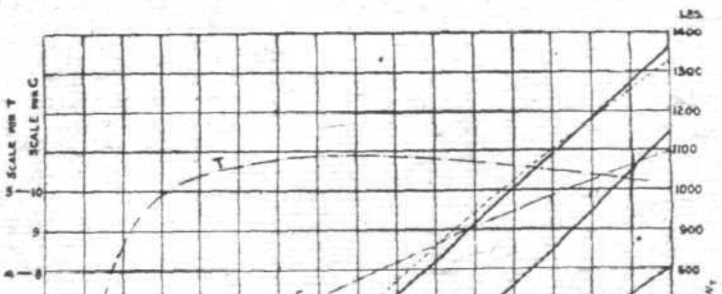


Fig. 3 Curve T is ton-miles per gallon for duration of four hours $= 1{\cdot}30\,\frac{L_U}{W_T}$. C is chord length of wings, in ft. $= {\cdot}08652\,\sqrt{A}$. W_T is total loaded weight (multiply scale ordinate value by 10) $= 7{\cdot}1\,A_W + W_W$. L_U is maximum useful load $= W_T - W_E$ (multiply scale ordinate value by 4). W_W is total wing weight (multiply scale ordinate value by 2). W_F is total fuselage weight, and W_T is total tail unit weight.

Control Cables, $W_C = 2{\cdot}29\,C$, in lbs.

Stress Load, $W_S = 7{\cdot}1\,A_W = 7{\cdot}1 \times 13{\cdot}36\,C^2 = 94{\cdot}85\,C^2$, in lbs.

Total permissible loaded weight, $W_T = W_S + W_W$.

For power loading of 20 lbs./h.p., b.h.p. $= {\cdot}05\,W_T$.

Weight of total power plant dry and without tanks $W_E = 3{\cdot}3 \times$ b.h.p., in lbs. $= {\cdot}165\,W_T$. [W_E includes engine (dry) with airscrew hub, exhaust manifolds, engine mounting, engine cowling, radiator (dry) with mounting and shutters, piping for petrol, oil, and water.]

Weight of complete landing gear, $W_U = {\cdot}0331\,W_T$.

Weight of Tanks

"To revert to weight of tanks. I have attempted to get out a formula for tank weights, based more or less on the results of experience. I have assumed a cubical form for the tank, which is a form easy to make and convenient to instal ; and as the *fuselage* is usually of square or rectangular cross section, a larger capacity can be obtained by using tanks of the form of a cube than of a cylinder. (See Fig. 2).

(Capt. Barnwell then deals with the size and weight of tank details, from a consideration of which he deducts the following.—ED.) :—

Tank capacity in gallons, $G = 6{\cdot}2\,L^3$.
Tank weight in lbs., $W = 1 + 1{\cdot}3\,L + 7{\cdot}7\,L^2 + {\cdot}4\,L^3$ where L is length of edge in feet.

"Whence we may write :—Weight in lbs., $W = 1 + {\cdot}71\,G^{\frac{1}{3}} + 2{\cdot}29\,G^{\frac{2}{3}} + {\cdot}065\,G$.

Total Weights

"We are now in a position to sum up total weights and thence to find the load-carrying value. The total loaded weight, W_T, is equal to $7{\cdot}1\,A_W + w_W$.

"The total weight empty, W_E, is of course the sum of the weights of wings, *fuselage*, tail unit, undercarriage, constant weight, control cables, power plant dry, air screw, and tanks required for 4 hours. To the weight empty, W_E, must be added weight of petrol, oil and water for flight duration required, and also weight of pilot (and other member or members of crew, if any), to give what I shall call the flying weight, W_F. Then :—

"Total loaded weight, W_T – Flying weight, W_F = useful load, L_U.

"Using all these methods, then, I have calculated the weights, for chord lengths, C, varying by ·55 ft., from C = 3·3 ft. up to C = 11·0 ft., and have run curves for them on a base of Wing Area, or value of $13{\cdot}36\,C^2$. (See Fig. 3.)

"These curves refer strictly to the case of a two-bay biplane of the over-all proportions of the 'Bristol' Fighter, with maximum normal horse-power numerically equal to one-twentieth of the total loaded weight in lbs., with petrol, oil, water and tankage for 4 hours' duration at maximum normal power, and with 'crew' consisting of 180 lb. pilot only. They also refer strictly to a stress loading of 7·1 lbs. per square foot of wing surface, and 'Commercial Class' strength on this stress loading. The curves run are :—Basic chord length, C, in ft. ; total wing weight, w_W, in lbs. ; *fuselage* weight, w_F, in lbs., tail unit weight, w_T, in lbs. ; total loaded weight, W_T, in lbs. ; useful load, L_U, in lbs.

"I have not run the curves for power plant weight, W_E, nor for landing gear weight, w_U, as these are respectively ·165 and ·0331 of W_T ; nor have I run the curves for petrol oil and water, for tanks and for air screw.

Ton-Miles Per Gallon

"One other curve is run on this diagram, the curve to obtain which all the foregoing has been necessitated, namely a curve of ton-miles per gallon, T.

Ton-miles per gallon is :—

$$\frac{L_U}{2{,}240} \times \frac{\text{Speed, in miles per hour}}{\text{Petrol consumption, in galls. per hour}}$$

"It is affected by duration inasmuch as the greater the required duration, the greater the necessary initial weight of petrol, oil and water, the greater the necessary weight of tanks, and consequently the smaller the useful load. In the particular case, for variation in size of an aeroplane, which we are considering, we have kept the horse-power per lb. total weight constant, we have kept the overall proportions constant, we have kept the stress loading constant, we have kept the air-screw efficiency constant. So if the wing loading were constant the speed would be constant. Now the wing loading is not quite constant, because it is the sum of the constant *stress* loading (per square foot) and of the total wing weight (per square foot), and this latter increases slightly as the size increases. When the wing area is 200-

sq. ft., for instance, the wing weight is ·712 lbs. per sq. ft. and the wing loading therefore 7·812 lbs. per sq. ft., whilst when the wing area is 1,600 sq. ft. the wing weight has gone up to 1·41 lbs. per sq. ft. and consequently the wing loading to 8·51 lbs. per sq. ft. The differences are fairly slight, but would make a difference to speed; on this power loading (of 20 lbs. per h.p.), the speed would be about 100 miles per hour for 7·8 lbs. loading and about 102½ miles per hour for 8·5 lbs.

"In the curve of ton-miles per gallon, T, here given, I have (for simplicity) neglected this slight speed variation and considered the speed as constant and as 100 m.p.h. The numerical value for ton-miles per gallon then becomes

$$1\cdot 3\frac{L_c}{W_T}$$

"It is interesting to note that ton-miles per gallon is a maximum for a machine of about 800 sq. ft. wing area. Obviously it falls off more and more rapidly below this optimum size, because the constant weight of pilot (180 lbs.) + the other previously tabulated constant weight of 81 lbs., represents a large proportion of the total weight as this decreases. It falls off, though much less rapidly, above this optimum size, because the increasing structural weight per square foot is becoming of greater moment than is the decreasing ratio of constant weight to total weight. If the slight variation in speed were taken into account, the curve of ton-miles would be slightly modified, being increased more and more as the size increased, but the alteration would be fairly small—at 1,600 sq. ft., for instance, it would be about 5·18 instead of 5·05, at 800 sq. ft., 5·51, instead of 5·44, whilst at 200 sq. ft. it would remain the same.

"Sufficient for our present purpose, however, to say that for a duration of 4 hours and a 'crew' of one, an aeroplane of about 800 sq. ft. wing surface seems about the most economical size, and can accomplish 5·51 ton-miles per gallon.

"A point of interest is the amount of improvement due to decreasing duration of flight, and thereby increasing the possible useful load. For this 800 sq. ft. aeroplane, if we decrease the duration to 3 hours, the ton-miles go up to 5·86, and if we decrease the duration to 2 hours, the ton-miles go up to 6·15. However, it is probable that a range of 300 miles is about the minimum that will be required for commercial aeroplanes in the near future, so fuel, oil and water for 4 hours at 100 m.p.h., air speed does not leave excessive margin for adverse conditions, and we shall say that our typical machine must carry this.

On Improvements

"Let us now consider what can be done in the way of improvement. The aeroplane we have arrived at is a biplane of 800 sq. ft. wing surface, of 6,545 lbs. total loaded weight, of 327·3 maximum normal horse-power, with a speed of 101·3 m.p.h., and a duration of 4 hours at this power. The useful load is 2,737 lbs., and the ton-miles per gallon 5·51.

"The weights consist of :—

	lbs.
Total wing weight, w_W	866
Fuselage weight, w_F	315
Tail unit weight, w_T	147
Total landing gear weight, w_U ..	216
'Constant' weights and control cables	99
Giving a total structural weight of	1,643
Total power plant (dry)	1,080
Airscrew	61
Petrol, oil and water for 4 hours, *i.e.*, 90 gallons petrol, 3·8 gallons oil and 9·4 gallons water	780
Petrol tank	56
Oil tank	8
Giving a total power-plant-for-4-hours weight of	1,985

"(A) Firstly to consider the effect of fuel economy:—The engine is absorbing ·55 pint of petrol per b.h.p. per hour, so its thermal efficiency is only about 23 per cent. If it were possible to double the thermal efficiency, we should be able to scrap 325 lbs. of petrol and 20 lbs. of petrol tank, meaning that we could add this 345 lbs. to the useful load, thereby bringing this up to 3,082 lbs. and the ton-miles up to 6·21. (B) Assuming the efficiency of the engine, in weight per b.p.h. could be doubled, we should be able to scrap one half of the engine (dry) weight, or about 435 lbs., and we could add this weight to the useful load, thereby bringing this up to 3,172 lbs. and the ton-miles up to 6·39. (C) Assuming that, to a small extent by improved disposition of parts, to a small (but not so small) extent by improved detail design of parts, to a very large extent by employing improved materials, we could reduce the whole structural weight by one half. We should then be able to scrap 978 lbs. of aeroplane weight and add this weight to the useful load, bringing it up to 3,715 lbs. and the ton miles to 7·48.

Aerodynamic Improvements

"The foregoing are all problems in structures and structural materials, let us now turn to aerodynamic considerations.

"The engine power is 327·3, the speed 101·3 m.p.h. and the propeller efficiency about 82 per cent., so the thrust,

$$T = \frac{327\cdot 3 \times 550 \times \cdot 82}{148\cdot 8} = 995 \text{ lbs.}$$

"The total drag is equal to the thrust, of course, and the following is approximately how this drag would be apportioned :—

		lbs.	Per cent.
r_R	Body	335	33·7
	Landing gear	160	16·1
	External struts and wires of wings..	68	6·8
r_S,	Tail unit	69	6·9
r_W,	Wings (alone)..	363	36·5
		995	100·0

"The drag of the wings (*alone*) has been fixed on the assumption that their lift over drag is 18, which is probably about correct for this case, namely full-size biplane of aspect ratio 7, with rounded off and fined down tips when the absolute lift coefficient, L_C, is about ·156.

"First then is it possible to reduce this figure of 363 lbs. of wing drag, r_W? By using a monoplane form, of aspect ratio about 10, and reducing the area till the loading became about 11 lbs. per square foot, we could probably achieve an L/D ratio of about 25. If the wing structure could then be of the same weight (which is certainly untrue), we should reduce the wing drag to 262 lbs., meaning that we should reduce the total drag from 995 to 894 lbs. at 101·3 m.p.h. This reduction, of about 11 per cent., would allow of an increase of speed, *for the same power*, of about 3·6 per cent., and would therefore put the speed up to about 105 m.p.h. and the ton miles up to about 5·71.

"Next to see what can be done about body drag, the biggest item on the list. Now this body has a maximum cross section of about 18·4 sq. ft.; 15·2 sq. ft. of rectangular girder structure and 3·2 sq. ft. of curved top fairing. Thus for this (normal present-day) aeroplane body, with nose radiator, cockpit opening, wind screen, etc., the drag is about 18·2 lbs. per sq. ft. at 101·3 m.p.h. or about 8·2 lbs. per sq. ft. at 100 ft. per second. Now the drag of the best torpedo form, of square section, is only about 1·6 lbs. per square foot of maximum cross section at 100 ft. per second. So if it were possible to make the body of this optimum torpedo form, whilst maintaining the same maximum cross sectional area (of 18·4 sq. ft.), the drag would be reduced from 335 lbs. to about 65 lbs. But we should have to add radiator drag, and drag of wind screen and cockpit opening, or at any rate of some form of projection, to ensure a good field of view for the pilot. The minimum radiator drag at present practicable, to cool this engine (of 327 h.p.) at this speed (101·3 m.p.h.), is about 50 lbs. Probably we could arrange a fairing, with suitable sliding windows, over the pilot's head for an added drag of about 10 lbs.

"There is no reason why, by using a suitable spinner on the airscrew, the remainder of the body could not be made of torpedo form, so it would appear that we should be able to reduce the body drag from 335 lbs. to 65 + 50 + 10 = 125 lbs. This means that total drag would be reduced from 995 lbs. to 785 lbs. at 101·3 m.p.h. This reduction of about 27 per cent. would allow of an increase of speed, for the same power, of about 8·2 per cent., and would therefore put the speed up to about 110 m.p.h. and the ton miles to about 5·98.

"There is no reason why we should not eventually be able to construct a satisfactory retractable under-carriage, and therefore be able to dispense with the whole of the drag of this part in flight. This would reduce total drag from 995 to 835, or by 19 per cent., and would allow of an increase of speed of about 5·9 per cent., putting the speed up to about 107·5 m.p.h. and the ton miles to about 5·84.

"By choosing optimum wing position with respect to C.G. (of whole machine), and using the most efficient shapes for the various members of the tail unit, it is probable that the drag of this could be reduced from 69 lbs. to about 39 lbs. This would reduce total drag by about 3 per cent. and would therefore allow of increase of speed of about 1 per cent., putting speed up to about 102·3 m.p.h. and ton miles to about 5·56.

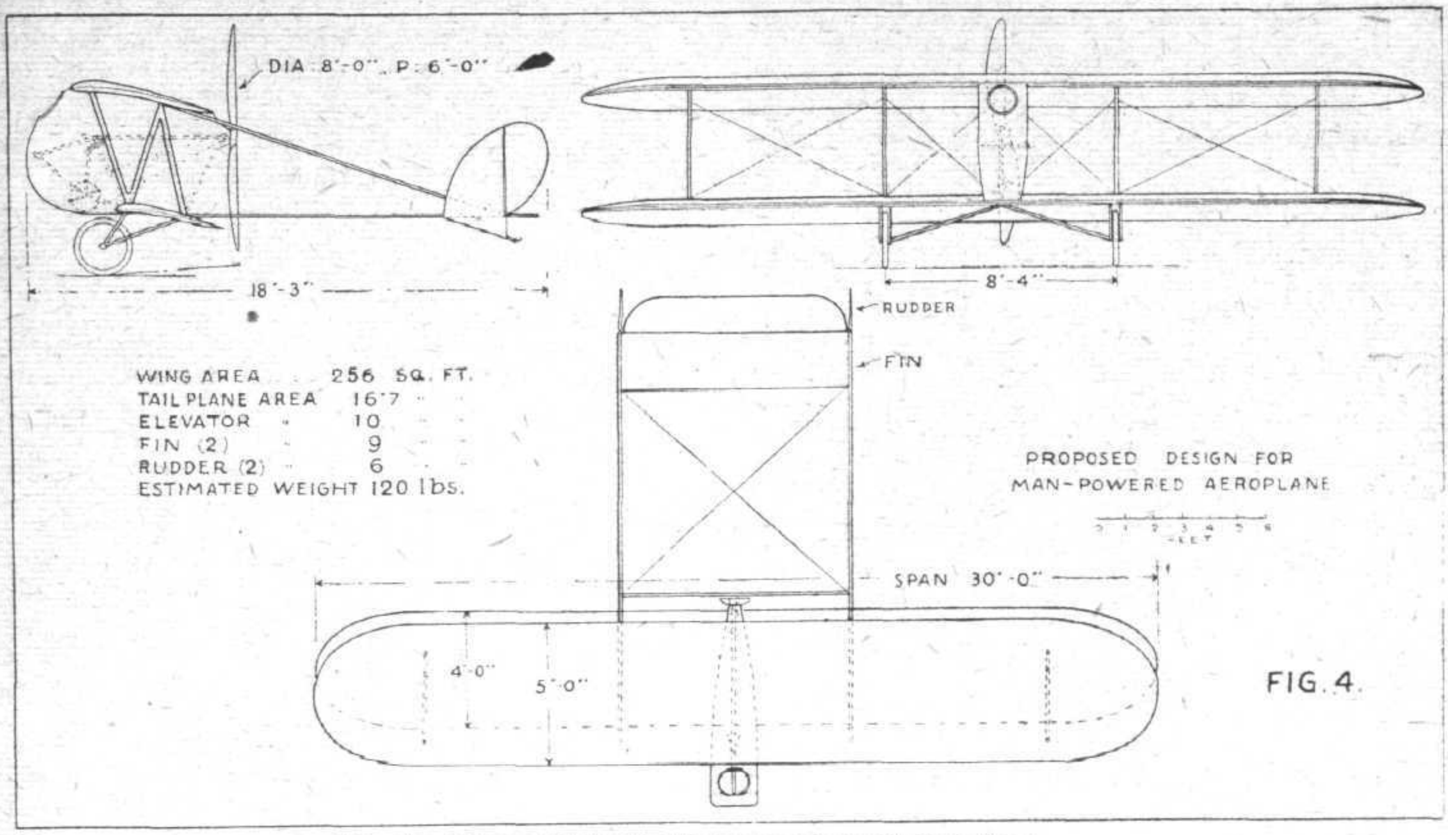


Fig. 4: Proposed design for man-powered aeroplane

"As regards external wing struts and wires, it is unlikely that we could reduce the resistance of the struts by much, but it is probable that the resistance of the wires (about 30 lbs. out of the 68 for struts and wires) could be reduced by about 60 per cent., by improving the section of the wires, and burying all the end fittings. This would reduce strut and wire drag from 68 lbs. to 50 lbs.

"It is probable that the resistance of all the wires and necessary pylons for the monoplane form, previously referred to, would not be greater than this biplane figure of 50 lbs., but the wing structure weight would certainly go up. It is also quite conceivable that tapered cantilever wings might be used, with as low a lift/drag ratio as the biplane surface (*i.e.*, 18), and that the strut and wire drag could thereby be washed out. But again it is quite certain that the weight of such wings would be greater than that of externally braced ones. The matter being so indeterminate therefore (particularly as we know little about the efficiency of full size wings and practically nothing about tapered wings), it is safest to say that the best we ought to expect is a reduction in drag of wings, struts and wires of about 28 lbs.

"Now all these aerodynamic improvements are present-day possibilities, and could all be on one and the same machine. On this 'perfected' machine we should have the following drags, at 101·3 m.p.h. :—

	Lbs.
Body	125
Landing gear	0
Tail unit	39
Wings with external struts and wires ..	403
	567

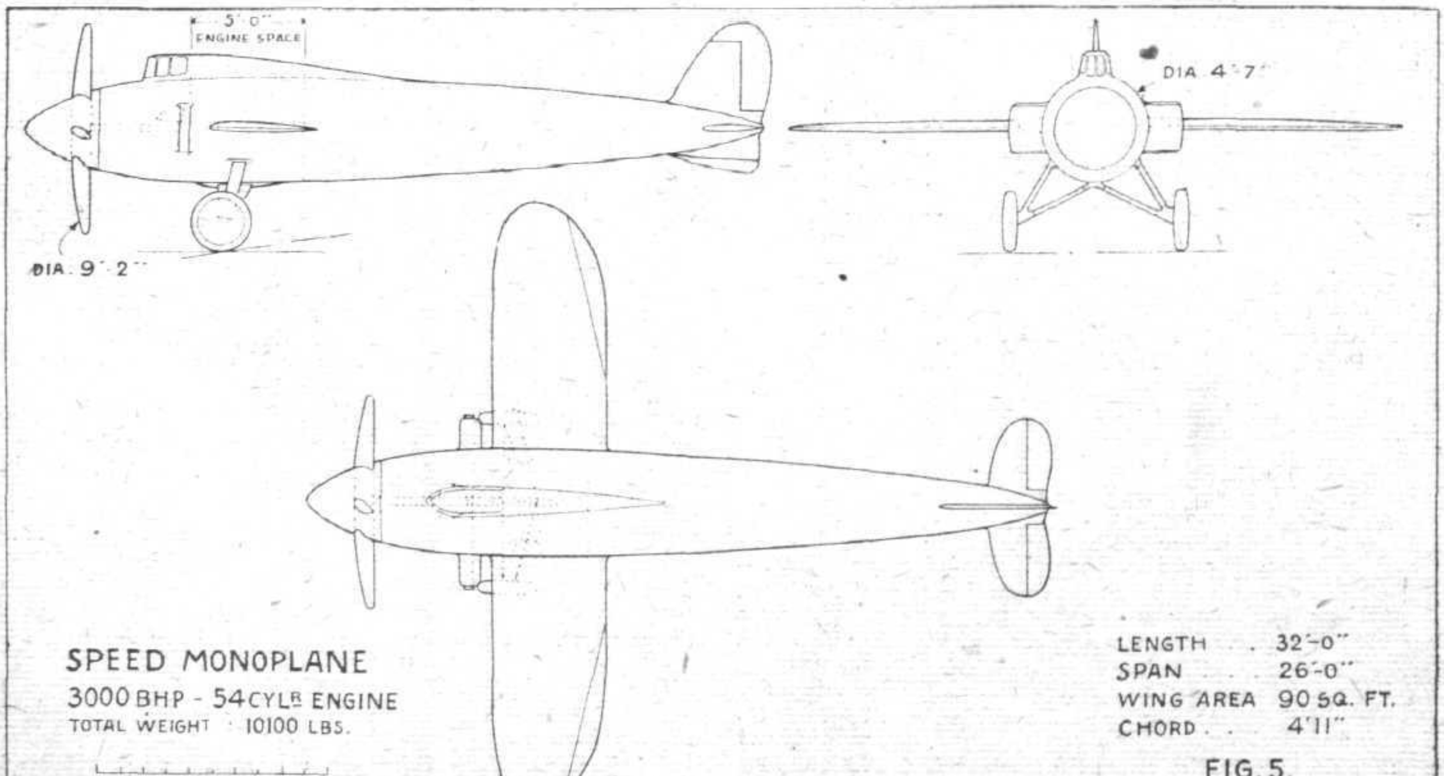


Fig. 5: Proposed design for speed monoplane

"The total drag is therefore reduced from 995 lbs. to 567 lbs., that is by about 75 per cent., so the speed would go up by about 20·3 per cent., or to about 122 m.p.h. We shall do, for this *totalised* condition, what was omitted in considering the improvements obtainable by *item* drag reduction, that is, we shall take into consideration the saving in petrol and oil due to keeping the *range* the same. We had originally 4 hours duration at 101·3 miles, or a range of 405 miles. At this increased speed of 122 m.p.h., therefore, we only need 3·32 hours duration, to maintain the 405 miles range. So the petrol, fuel and oil will be reduced by about 220 lbs., and the tanks by about 10 lbs., whence the useful load can be increased from 2,737 lbs. to 3,067 lbs. This combined result, of increased speed and increased useful load, is to improve the ton miles per gallon from 5·51 to 7·44."

Capt. Barnwell then concluded his paper with a brief outline of two machines which may be said to represent the "outside edge" of design. One of these was a man-driven machine, the general arrangement of which is shown in the accompanying illustration, Fig. 4. After making estimates of weights, resistances, etc., and assuming that a man can develop one horse-power for a short time, Capt. Barnwell comes to the conclusion that it appears to be impossible for a human being to fly by his own power unless he can develop at least one and a half horse-power, or unless we can obtain materials and efficiencies at present out of our reach.

The second machine to which Capt. Barnwell referred is a design for a pure speed machine, of the general arrangement shown in Fig. 5. It is, of course, a purely imaginary design, in which no attention has been paid to cost, and little or none to safety—as the figure for landing speed will show. The engine which Capt. Barnwell imagines for such a machine is a 54-cylinder job, with a six-throw crankshaft having nine cylinders arranged radially around each crank pin. The weight all-on but "dry" is estimated at 6,000 lbs. and the maximum b.h.p. at 3,000 h.p. at 2,100 r.p.m. The estimated total weight of such a machine is 10,100 lbs., the wing area 90 sq. ft., the wing loading 112 lbs./sq. ft., the top speed about 380 m.p.h., and the stalling speed 190 m.p.h. If a retractable chassis is fitted, which is absolutely buried during flight, the wing area would become 60 sq. ft., the wing loading 168 lbs./sq. ft., and the maximum speed about 470 m.p.h. Such a machine, it will be realised, is only achieved by the entire sacrifice of utility, and by using a wing loading which would require a large aerodrome to arise from and a vast aerodrome on which to land, both with excellent surfaces.

HONOURS

THE following appeared in the New Year Honours List :—

The King has been graciously pleased to signify His Majesty's intention of conferring Peerages of the United Kingdom on the following :—

To be a Baron

SIR WILLIAM BEARDMORE, Bart.—Sir William Beardmore is chairman and managing director of William Beardmore and Co., Limited, engineers and ordnance manufacturers, Parkhead Forge, Glasgow. He is also chairman of Arrol-Johnston, Limited, and is a director of Vickers, Limited, and a number of other companies. He was President of the Iron and Steel Institute in 1917.

The King has been pleased to approve of the following appointment to the Order of the Bath :

C.B.

BASIL EDWARD HOLLOWAY, Director of Finance (Materials), Air Ministry.

The King has approved of the following award :—

Bar to the Air Force Cross.—Flying Officer THOMAS AUDLEY LANGFORD-SAINSBURY, A.F.C., R.A.F. (Air Force Cross gazetted January 1, 1919).

Foreign Honours

IT is announced that the following decorations have been conferred by the Allied Powers on the officers of the Royal Air Force in recognition of valuable services rendered in connection with the war. The King has given unrestricted permission to the officers to wear the decorations in question.

CONFERRED BY THE EMPEROR OF JAPAN.

Order of the Sacred Treasure.

First Class.—Air Marshal Sir H. M. Trenchard, Bt., K.C.B., D.S.O.

Third Class.—Wing Com. B. R. W. Beor, O.B.E. ; Lieut.-Col. T. B. Phillips, O.B.E. ; Lieut.-Col. R. D. Waterhouse, C.M.G.

Order of the Rising Sun

Second Class.—Maj.-Gen. Sir F. H. Sykes, G.B.E., K.C.B., C.M.G.

Third Class.—Col. E. H. Davidson, C.B.E., M.C. ; Lieut.-Col. A. C. H. Maclean, C.B.E.

Fourth Class.—Sqdn. Ldr. L. F. Forbes, M.C. ; Sqdn. Ldr. F. W. Stent, M.C. ; Maj. G. G. Adeley ; Maj. R. Chadwick, M.C., D.C.M.

Fifth Class.—Capt. W. H. J. Eldridge ; Capt. F. G. Hogarth ; Capt. R. R. Prentice ; Lieut. D. C. W. Sanders, A.F.C.

CONFERRED BY THE KING OF THE BELGIANS

Order de la Couronne

Officier.—Lieut.-Col. T. B. Phillips, O.B.E.

D.F.C. for King Albert

FROM Brussels comes word that early this month the Duke of York will pay a visit to the Belgian capital with the object of presenting to King Albert the Distinguished Flying Cross. On the same occasion the chiefs of the Belgian Military Aviation Service will offer to King Albert the badge of their corps—two wings joined on the letter A.

R.A.F. College

THE following are declared by the Civil Service Commissioners to be the successful candidates at the competitive examination held in November, 1920, for admission to the R.A.F. Cadet College ; but their admission is conditional on their having passed the medical examination :—

Royal Air Force Cadet College

*Gillmore, V. O.	10,761	*Goldsmid, F. F. R.	7,255
Randle, G. H.	9,753	*Carter, N.	7,160
Newall, J. S.	9,627	*Tracy, J. McL.	6,718
Cator, F. G.	9,375	Brown, R. C. J. H.	6,543
Carter, R. H.	9,374	Sloan, W. J. P.	5,913
Nicholetts, G. E.	8,486	Burkinyoung, E. H.	5,793
*Lewes, R.	8,060	Jordan, R. B.	5,508
MacGregor, P. J.	7,955	Nuttall, F. E.	5,375
Fitzmaurice, M. J.	7,703	*Harris, F. S.	5,167
*Apthorp, D. F. A.	7,258	Fressanges, F. J.	5,052

Honorary King's Cadets who have qualified.

Berridge, T. D.	7,201	Lywood, R. W. G.	5,329

* These candidates have received marks for military efficiency.

Aircraft for Polar Research

LECTURING on the "Future of Polar Exploration" before the Royal Geographical Society, recently, Mr. Frank Debenham said the airship may at once be dismissed as being far too expensive and fragile for transport purposes, except when working from civilized and inhabited centres. For detailed work the heavier-than-air machine is much more likely to be of value. But the chances of a safe landing with an aeroplane on such country would be very small. By seaplanes from ships, excellent work could be done, and they might add considerably, not only to speed of manœuvre in pack-infested waters, but to the chances of survival of a beset ship. The seaplane would have a very definite value as a pilot alone, even though it could only be employed in comparatively loose pack-ice. As an auxiliary for plotting coastlines it would be invaluable. The enclosing of both engine and crew in a suitably-shaped body would overcome many practical difficulties of temperature and air-blast ; the evolution of special alternative landing-gear to adapt the seaplane to emergency landing on sea ice would be another line of experiment likely to produce fruitful results.

A Thrilling Balloon Voyage

THE U.S. naval balloon, commanded by Lieut. Hinton, one of the officers who crossed the Atlantic in the N.C.4, which was reported missing after leaving Rockaway, New York, on December 13, landed on the next day at an old post at the mouth of the Moose River, North Ontario, after covering a distance of more than 1,000 miles. Lieut. Hinton and his two companions were lost in a forest for four days and eventually reached the Hudson Bay Co.'s post at James Bay, from which news of their safety was conveyed by Indians to Mattice, the nearest telegraphic office on the transcontinental railway.

The Death of Mr. J. L. Hall

IT is with regret that we have to record the tragic death of Mr. John L. Hall, which occurred on the evening of Christmas Day in London. It appears that Mr. Hall, who will be remembered as the proprietor of the Hall Flying School at Hendon, had suffered very severely from neuralgia during the last four years.

Crash at Capetown

A BRIEF cablegram from Capetown states that as a result of a crash on December 27, four persons were killed. It appears that an aeroplane was being used for joyrides and on the third trip the machine crashed into a tall sewerage chimney and then dropped to the ground, where it immediately burst into flames. All efforts to quell the conflagration proved unavailing until the fire brigade arrived. The occupants, consisting of the pilot, Captain Hemming, D.F.C., two lady passengers, and a child, were killed.

"Airship Flights of Fact and Fancy"

AIR-COMMODORE E. M. MAITLAND, C.M.G., D.S.O., A.F.C., has consented to give the annual juvenile lecture at 3 p.m., on the afternoon of Tuesday, January 11, at the Royal Society of Arts, John Street, Adelphi, on "Airship Flights of Fact and Fancy." The lecture will be very fully illustrated with lantern slides. Tickets for the children of members and their friends may be obtained from the Secretary, Royal Aeronautical Society, 7, Albemarle Street, London, W. 1.

German's New Anti-Aeroplane Gun

IN connection with the resignation of the French Minister of War it is stated that the French Intelligence Service ascertained that among the new types of machine-guns evolved by the Germans was a heavy machine-gun for use against aeroplanes flying low over the infantry lines, and also against tanks. It was tested in August, 1918, at the trial grounds at Ham. The two barrels moved together, but were controlled by a single trigger, which in one model was placed between the barrels and in another beneath the right barrel. It was swung on a pivot mounted on a heavy stand.

Although in the final German retreat in 1918, the battlefields were scoured in search of these new types of weapon, none was ever captured, and none was among the 125,000 machine-guns surrendered under the terms of the Armistice. The French Government possess reliable information that they have been further improved and manufactured. It is this knowledge which, in part, prompted M. Lefèvre to resign rather than to agree to the proposals of his colleagues for the reduction of the French Army under the new Bill.

More Hidden Stores in Germany

FROM a message emanating from Detmold (Lippe) it appears that aviation stores to the value of a million marks were discovered on December 15, in a wood near Bad Salzoflen. Evidently the stores, including eight large crates containing 8 aeroplane motors, propeller parts, etc., formerly belonging to the Army, and ordered to be destroyed by the Inter-Allied commission, were to be removed elsewhere. They were all seized by the authorities.

The "L 120" goes to Italy

THE Zeppelin "L 120," which is said to have taken part in three raids on London, and allotted to Italy under the Treaty of Versailles, arrived over Rome on the afternoon of Christmas Day, having left its shed at Staaken, near Berlin, on the previous evening.

The Michelin Cup for Commercial Machines

FOR this year's competition for the Michelin Cup and the eighth (and last) of the series of prizes of 20,000 francs, a course of 3,000 kilometres round France has been mapped out, starting from and finishing at one of the aerodromes near Versailles (Buc, Villacoublay, Toussus, Châteaufort). The winner will be the pilot who, before January 1, 1922, covers the course at the highest speed practicable for commercial aviation. Stops will have to be made at the following points:—Amiens, Châlons, Saint-Dizier, Gray, Joigny, Vienne, Nimes, Pau, St.-André-de-Cubzac, Romorantin, Angers, Evreux, Saint-Inglevert (8 kilometres from Calais) and Versailles (Buc, Villacoublay, Toussus, Châteaufort).

The Panama Canal and Aerial Attack

IT is evident that the effective work of bombarding squadrons in the War is not being lost sight of in American military councils. The latest indication of this is the announcement that a Bill will shortly be introduced into Congress by the Fortifications Committee to make the Panama Canal impregnable against attack from the air, land or sea.

COMPANY MATTERS

A. V. Roe and Co.

DIVIDEND on the ordinary shares of 14 per cent. for the year ended April 30, and a further dividend of 3½ per cent. on the participating preference shares, making 13½ per cent. for the year.

S. Smith and Sons (M.A.), Ltd.

THE net profit for the year ended July 31, 1919, after providing for excess profits duty (estimated) and income-tax, was £59,444, plus £8,344 brought forward, making £67,789. Dividends absorbed £39,375, directors' fees £1,500, carried forward £26,914.

The net profit for the year to July 31, 1920, after providing for all necessary charges, estimated liabilities for corporation tax, income tax, and adjustment in connection with excess profits duty, is £98,337, plus balance brought forward, £26,914, making £125,251. Interim dividend on ordinary shares absorbed £15,750, directors' fees £1,750, leaving available £91,451. The works are now fully organised to manufacture various products under most favourable circumstances, and branches and connections throughout the world have all been extended and the whole cost has been charged against revenue. The directors do not consider it in the best interests of the company at present to recommend a further dividend on ordinary shares. In view of the bankers declining to grant further facilities, the Board has decided to create debentures to secure £600,000. It cannot at present be decided as to whether these debentures in whole or part will be offered for subscription or used as security for present loans and obtaining such further advances as may be necessary to carry over period until stocks can be reduced.

NEW COMPANY REGISTERED

CONTROLS, LTD. Office: 66, Piccadilly, W.—Capital £1,000, in £1 shares. Makers of and dealers in flexible wire and rod controls for internal combustion engines, etc. W. M. Rolph (Governing Director).

AERONAUTICAL PATENT SPECIFICATIONS

Abbreviations: cyl. = cylinder; I.C. = internal combustion; m. = motors

The numbers in brackets are those under which the Specifications will be printed and abridged, etc.

APPLIED FOR IN 1916

Published January 6, 1920

18,274. V. C. RICHMOND. Gas-stopping linings for airships, etc. (154,942.)

APPLIED FOR IN 1919

Published January 6, 1920

21,109. A. L. MCKELVEY. Aircraft. (154,970.)
22,392. G. CAPRONI. Flying-machines. (132,524.)
22,904. P. W. SCHOLLAR and E. R. CALTHROP'S AERIAL PATENTS. Parachutes. (155,041.)
32,105. E. S. DARLEY and E. W. ENGLAND. Horizontally-arranged self-feathering propeller. (155,115.)

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